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ON THE COVER: With its ordnance on display, the FMS P-47D Razorback 1500mm model does justice to its big brother. This month, we pay tribute to the P-47 Thunderbolt with this review, a guide, and a feature on the full-size aircraft. (Photo by Peter Hall)

THIS PAGE: Flying wings equipped with FPV gear provide the ultimate RC racing thrill! Don't miss Dave Stock's article on drone racing on page 60. (Photo by David Stock)

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Preflight

BY DEBRA CLEGHORN | EXECUTIVE EDITOR

Exclusive to *Model Airplane News*, this FMS P-47D Razorback is one of eight Thunderbolt models featured in this issue.

A Tribute to Thunderbolts

In this month's *MAN*, we salute the Republic P-47 Thunderbolt. This World War II heavy-metal fighter was a warhorse. Outfitted with eight .50-caliber machine guns and a bombload capacity of 2,500 pounds, this aircraft saw extensive action in the European and Pacific theaters. Its 2000hp engine could pull the aircraft at speeds exceeding 525mph. This plane was not only deadly and fast but also durable and well known for returning pilots safely home. To this day, there are many P-47s still airworthy and many more on display. I was fortunate to see an airworthy P-47D (painted to replicate the original "Tarheel Hal") when I was at the Lone Star Flight Museum in Galveston, Texas, not too long ago. In this issue, we pay tribute to the P-47 with our exclusive review of the FMS P-47D Razorback 1500mm, the editors' top Thunderbolt model picks, and the feature story "The Beautiful Brute Lives On," written by Budd Davisson, editor-in-chief of *Flight Journal*, our sibling publication. P-47, we thank you for your service.

ALSO IN THIS ISSUE

If you've ever thought about turning your RC flying hobby into a career, you won't want to miss our feature article "Higher Learning." Packed with information on courses that range from online seminars to degree programs, this is a great place to start if you'd like to fly for a living.

New E-zine: *Drone School*

This 73-page collection of articles from *RotorDrone* magazine will give you a better understanding of drones, from the basics of the aircraft to gear and gadgets, mastering flight, and troubleshooting tips. *Drone School* covers topics that range from an introduction for the novice pilot to advanced tips that even the veteran pilot will find useful. Some features include:

- **THE BASICS:** *From how a multirotor works to radio basics and FPV systems*
- **FLIGHT SUCCESS:** *Flight modes, programming a flight controller, eliminating flyaways, and more*
- **GEAR AND GADGETS:** *Building a quad kit, soldering techniques, speed-control secrets, and battery care*
- **FREQUENTLY ASKED QUESTIONS:** *Readers' questions tackled by our experts, plus key tips to help you succeed at creating a business flying your drone*

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YOUR FEEDBACK

We love hearing from our readers: Your emails, tweets, and comments quickly let us know what you'd like to see more (or less!) of in upcoming issues and online. Here's what some of you are saying about *Model Airplane News* magazine.

ModelAirplaneNews.com Skyraider Project

With our ongoing Build-Along posts on the *MAN* website, the latest installment of Gerry Yarrish's 85-inch Douglas Skyraider highlights what needed to be done to install Robart's 90-degree rotating gear in the new-size wing. As the model is a reduced version of the Nick Ziroli 100-inch Skyraider plan, there was some tinkering involved. Here's what some of you had to say.

Brad Hensley: Your wing is looking good, Gerry. The extra width of the 148E gear is nice, but the revision required is unfortunate. Are you going with the stock mount height? I added blocks to the normal mount beams on my 100-inch to extend the gear downward for a more scale appearance.

Bernie Jager: Hi, Gerry. Great project for learning about building and modifying.

Adam Smith: I always like Nick Ziroli's warbird designs, but like you, a 100-inch warbird is just too big for me to transport easily. I will be checking your progress to see how the new 85-inch version turns out.

Bruce Kucharski: Good job, Gerry. Nice to see, in this world of ARFs, that there still is interest in building.

Vic Minetola: All the comments and replies to this build series is like a class of students and emeriti hunched over around an operating theater watching surgeons perform. I'm hunched over among them. Great build process!

Roger Whitman: I love Robart retracts. Good luck with your build.

In Our Mailbox Night Flying

Your timing could not have been better. I have been looking for a quick-and-easy project to do some night flying, and right there in your March issue was Lou Cetrangelo's review of the Night Walrus from HobbyKing! Thanks for the timely news.—*Paul Volmer, Phoenix, AZ*

Paul, no problem! Glad we could help you find a good night flier. Lou said that he has nothing but praise for Night Walrus and loved extending his flying time till after dark. Good luck.—*GY*

Facebook Monster Soviet Fighter

Videos of really big RC fighters always do well on our Facebook page, and recently we posted one from Zdenek Sladek showing a Lavochkin La-7. With a monster radial engine in its big round cowl, the sound alone stirs the emotions for anyone who loves this classic Soviet fighter. Here are some of your comments.

TR: This is really rare. I admire you for your courage.

SS: A little bigger and he could pilot the darn thing himself.

JF: Wow, I bow to your skills, but man, you surprised me.

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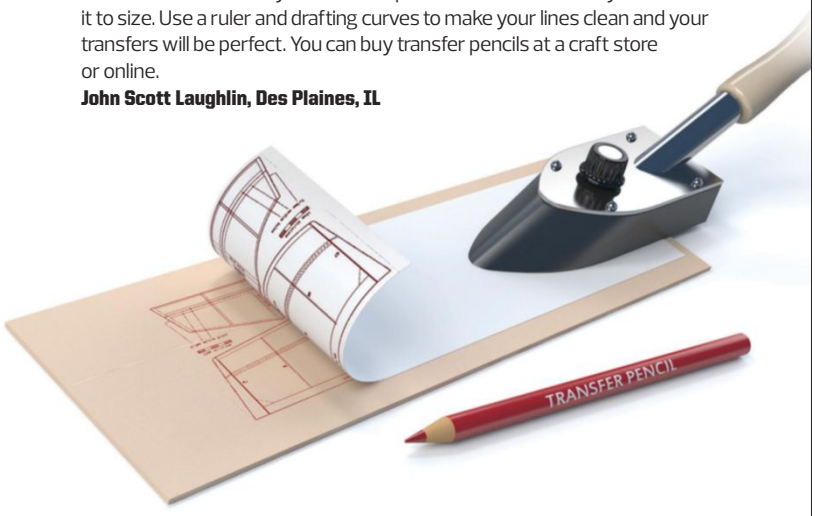
Tips&Tricks

USEFUL HINTS FROM MODELERS | Illustrations by Richard Thompson

TRANSFER PENCILS

Here's a tip to keep your plans clean and in one piece. Use a transfer pencil to trace the parts from the plans (you can also draw new parts on paper), then place it image-side down on a piece of wood. Simply go over the pattern with a hot iron, and the heat will cleanly transfer the part to the wood so that you can then cut it to size. Use a ruler and drafting curves to make your lines clean and your transfers will be perfect. You can buy transfer pencils at a craft store or online.

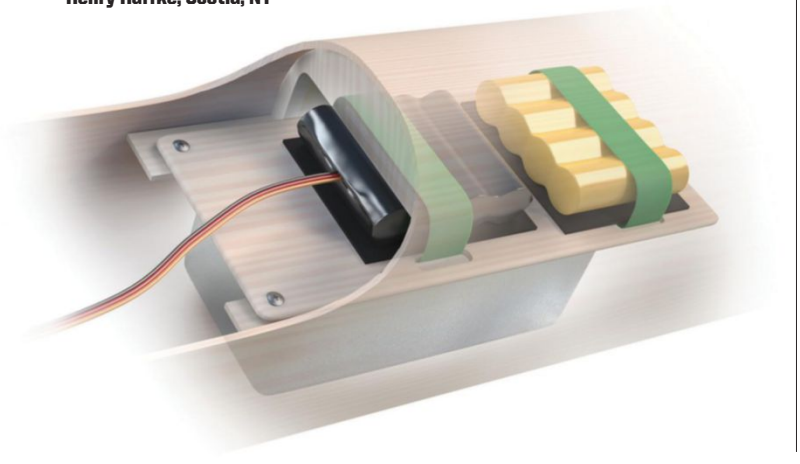
John Scott Laughlin, Des Plaines, IL



REMOVABLE TANK TRAY

When I built a giant-scale Howard Ike "Miss Chevrolet" racer with *MAN* senior editor Gerry Yarrish, we came up with a nifty way to install the fuel tank, the engine ignition, and the radio battery packs so that they fit securely yet are easy to remove for servicing. We use a light-ply tray slid into place between two built-up wood channels glued to the sides of the inner fuselage. The tank and batteries are attached with Velcro straps and foam-rubber padding. You can easily slide it into place through the wing saddle when the wing is removed and secure it with two self-tapping sheet-metal screws. Remove the screws and it slides out for maintenance.

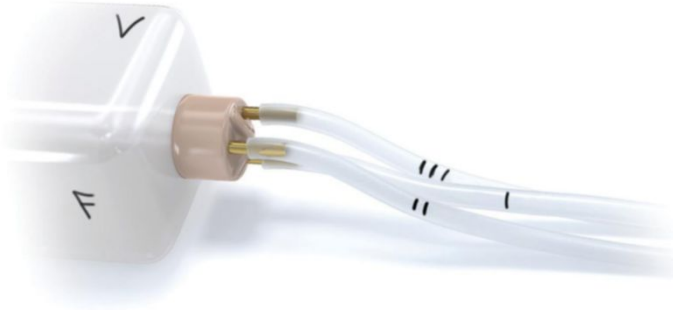
Henry Haffke, Scotia, NY



EPOXY QUICK MIX

I use epoxy adhesive all the time when building my plane kits from scratch. I got so tired of mixing the two parts together with popsicle sticks; sometimes the epoxy wasn't mixed well enough and it took a long time to cure. So now, after pouring the resin and hardener into the mixing cup, I attach a disposable metal brush into an electric hand drill, pull the trigger, and stir away. I have an inexpensive drill with a long battery life that I use specifically for this technique. Simply do a quick reverse on the drill to release the brush handle, and use the brush to apply the epoxy. Be sure and tug on the bristles a few times to remove any that are not well attached to the brush.

Milby D. Dunn II, Houston, TX



FUEL-TUBE TRACKING

I like to use three-line fuel-tank setups, with a filler line fed from a fuel dot and a T fitting in the vent line going to another fuel dot so that I don't need to remove any lines while refueling. It can be difficult, however, to keep track of the fuel lines while installing the tank. To solve this, I use a Sharpie to mark the tank to show V (vent), C (carb clunk), and F (fill clunk), then mark one, two, or three bars on the loose end of each fuel line and write a list of which is which. This makes it easy to know which fuel line is which when you pull them out in front of the firewall.

Richard Hodgson, Agoura Hills, CA

SEND IN YOUR IDEAS! We want your ideas for Tips & Tricks! This month's winners will receive a *Model Airplane News* baseball cap. Send a photo or rough sketch and a brief description to MAN@airage.com or *Model Airplane News*, c/o Air Age Media, 88 Danbury Rd., Wilton, CT 06897 USA.

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Pilot Projects

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P-47D THUNDERBOLT

PILOT PROJECT OF THE MONTH

Vinicius Giovanetti, São Paulo, Brazil

No wonder this Jug, built from a Top Flite kit by Vinicius's friend Marcos, scored first place in a scale competition! Powered by an O.S. GT22 gas engine, the model has a ton of scale details and is dressed in the colors of the aircraft flown by 1st Lt. Gerald Grace of the 368th Fighter Group in the European Theater during World War II.

CLOUD DANCER **Chris Hickok, Lebanon, OR**

Built from the HobbyKing kit, this 53-inch-span model is powered by a brushless electric motor turning a Master Airscrew 3-blade 10x6 prop. Chris writes that the laser-cut parts build up like a 3D puzzle and adds that it's "just a joy to build and fly."

F-117 STEALTH **Bill Froeder, Mullica Hill, NJ**

This 1/8-scale model started life as an Aegis Aircraft kit. The 53-inch-span fighter has elevons and fixed rudders, and is modeled after "Stars and Stripes," the last F-117 ever built. The model has a fiberglass finish with Klass Kote paint. Bill made the chrome graphics and used Callie Graphics for the rest.

PHAETON II

John Stribiak, Yorkville, IL

This Balsa USA Phaeton II is John's first kit-built model, and it sports a few modifications, including a scratch-built cowl and a new top deck and tail feathers. (We're impressed!) The 54-inch-span plane is powered by an O.S. .50 SX engine and is covered in UltraCote.

SEND IN YOUR PICTURES! *Model Airplane News* is your magazine, and we encourage reader participation. Email your high-resolution images to MAN@airage.com, with your contact information and details on your project. Every pilot we feature will receive a *Model Airplane News* baseball cap, and the "Pilot Project of the Month" winner will receive a *Model Airplane News* "swag pack."

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Phoenix Westland Lysander .46–.55

During World War II, this aircraft's ability to take off and land in small spaces made it an asset for Allied troops operating behind enemy lines. Now you can fly this nicely detailed, 74.8-inch-span version! Intended for either glow or electric power, it requires a 4-channel radio system and costs $169.99. **towerhobbies.com**

Hitec Energy Propel Motor Combination Packs

With built-in, programmable speed controls and efficient, high-performance motors, these units save space on your multirotor and eliminate wires. They feature One Shot Synchronization Protocol for faster communication between the motor and speed control, and have updatable firmware. The four-motor packs are available in six sizes and start at $127.98. **hitecrcd.com**

Freewing A-10 Thunderbolt II

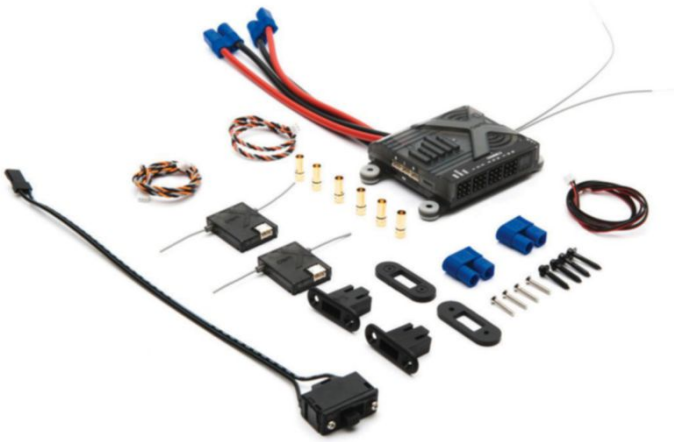
This 80mm high-performance jet has a wingspan of 67 inches and comes with suspension landing gear that can handle takeoffs and landings on grass fields. Scale details include LED lights, multiple decal sets, optional ordnance sets, and removable hardpoints. Add the optional 90mm power system for even more performance! The airframe can house a pair of 5S 4000mAh LiPos up to a pair of 6S 6600mAh LiPos. Pricing not yet available. **motionrc.com**

Hobbico Mini Digital Tachometer

To get maximum power and performance, you need to know your system's dynamic and peak rpm, and that's where this compact tachometer comes in. Just aim the tach at the prop and you'll instantly see the readings on its backlit LCD screen. The $29.99 unit comes with a CR2032 lithium-ion battery. **hobbico.com**

Tower Hobbies Sport GP/EP ARF

Whether you power it with a .46 to .55 two-stroke, a .70 four-stroke, or a 925-watt brushless motor, this sport aerobat offers stable, forgiving handling and easy landings. It comes with prehinged elevator and rudder, bays for miniservos cut out, and outlines for standard servos. This 60.2-inch-span model costs $119.99. **towerhobbies.com**



Spektrum PowerSafe Integrated Telemetry Receivers

Available in 9-, 12-, and 20-channel versions, these receivers have integrated full-range telemetry. Each comes with built-in connection ports for rpm, flight-pack voltage, and temperature sensors as well as an XBus port for additional telemetry options. They also have a bind button and are upgradeable. The 9-channel AR9130T costs $189.99, the 12-channel AR12300T is $199.99, and the 20-channel AR20300T is $219.99. **spektrumrc.com**

TechOne Ninjato 3D

Made out of light, durable EPO foam, the Ninjato is intended for experienced 3D pilots who are looking to unleash the most extreme maneuvers. The 39.3-inch-span aerobat is receiver-ready, so you'll just need a radio and receiver and a 3S 1000mAh LiPo battery. It costs $119.99. **towerhobbies.com**

Phoenix Outrageous

These two pylon racers come built and covered, so you can spend less time in the workshop assembling and more time at the field flying! The 61-inch-span .46–.55 model requires a 4-channel radio engine or equivalent electric motor and costs $159.99; the 80-inch-span 56–60cc model requires at least a 6-channel radio, engine, or equivalent electric motor and costs $529.99. Both models come with pilot figures. **towerhobbies.com**

Eagle Tree MicroVector Flight Controller

Whether you're into drone racing, freestyling, or serious camera drones, you need the MicroVector integrated flight controller. Its many features include a built-in on-screen display with color graphics and customizable screens, programmable video control, and built-in flight data recorder. It costs $99.95. **eagletreesystems.com**

Tactic FPV Wrist Monitor

Drone racing just got more exciting! This $49.99 unit's built-in 5.8GHz receiver with 32 channels and 2-inch LCD screen lets you access other pilots' point of view while you're waiting between heats. Change channels and bands with the press of a button. **tacticrc.com/fpv**

THE MAGNIFICENT SEVEN

THE EDITORS' FAVORITE P-47 THUNDERBOLTS

BY THE ***MODEL AIRPLANE NEWS*** **CREW**

One of the more iconic aircraft of World War II was the P-47 Thunderbolt. It was the workhorse of the American forces and was the biggest, heaviest, and most expensive single-engine fighter airplane used during the war. It had a Pratt & Whitney R-2800 Double Wasp engine, which provided enough power to carry a large number of bombs. But the thing pilots loved the most was its armor: The Thunderbolt could take hit after hit and still get her pilot home. This plane is one of our favorites, so we decided to do a roundup of the best P-47 RC aircraft we've reviewed. The following planes range from electric micro fliers to gas-powered, fiberglass composite models, and all get high marks from the *Model Airplane News* crew for their looks as well as their flight performance.

It could be Duxford — the sun just below the horizon and a fleet- footed line of youngsters of the 84th FS, 78th FG out of sight to the right, running toward their aircraft ready to have another go at bringing the German war machine to a halt. (Photo by Moose Peterson)

Top Flite **Gold Edition P-47 Thunderbolt**

Top Flite's classic bubble canopy Thunderbolt is a giant-scale warbird ARF that's easy to assemble, with an average completion time of 15 to 20 hours. This model is entirely built out of balsa and ply. The clear canopy comes painted and trimmed. There are also several preformed and trimmed ABS plastic pieces, which include the exhaust vents as well as the precut cockpit pieces. Also in the box is the precut and painted fiberglass cowl and belly pan. Finishing out the model is the genuine MonoKote covering that is applied well in the bright "Tarheel Hal" paint scheme. It's a joy to assemble: All parts fit together perfectly, and no modifications are required. With the exception of the rudder, all the control surfaces come preglued with hinge-point hinges directly from the factory. In the air, we found that takeoffs were extremely easy for such a large airplane. The giant-scale P-47 was solid as a rock from the initial taxi and takeoff to lightning-fast strafing passes, slow flight, and during landing. This baby can perform loops, spins, rolls, hammers, and Cuban-8s with ease. We were very pleased with this warbird's much-better-than-anticipated glide performance.

QUICK SPECS

WINGSPAN: 85 in.
WING AREA: 1,329 sq. in.
WEIGHT: 22.2 lb.
WING LOADING: 38.4 oz./sq. ft.
ENGINE REQ'D: 43 to 65cc gas
RADIO REQ'D: 5- to 7-channel
$649.99 | TOP-FLITE.COM

QUICK SPECS

WINGSPAN: 85 in.
WING AREA: 1,329 sq. in.
WEIGHT: 21 lb. 6 oz.
WING LOADING: 37.06 oz./sq. ft.
POWER REQ'D: 50-61cc gas or RimFire Power 65 160Kv electric motor
RADIO REQ'D: 6+-channel
$749.99 | TOP-FLITE.COM

Top Flite **Giant-Scale P-47 Razorback**

This Razorback model captures the lines and attitude of the full-scale Jug, and it is loaded with scale details. The model comes with all its major parts and subassemblies built and covered at the factory, including the fuselage, wing panels, and tail feathers. The wing panels come ready for aileron and flap servo installation as well as the retractable landing gear. Heavy-duty aluminum and plywood braces secure the wing panels together to create a large one-piece wing. Once in the air, you will find that this plane is a blast to fly and would be a great choice for a first giant-scale warbird. Its ground handling and low-speed stability are remarkable, but the real fun starts when you dive out of the sun to make a low-level, high-speed strafing run! Its glide performance is surprisingly good as the model has a decent glide ratio with power pulled back. The Top Flite P-47 Razorback is a great-looking model of the iconic warbird. For such a large airframe, the P-47 is easy to assemble and the parts fit extremely well.

E-flite/Horizon Hobby **UMX P-47**

This ultra-micro, easy-to-fly 4-channel warbird has Horizon's AS3X stabilization system for solid performance. It is constructed out of lightweight foam and uses an ultra-micro brushed electric motor with a scale-looking 4-blade propeller. Combined with the factory-installed speed control, you simply need to buy the recommended E-flite 2S 200mAh 7.4V 30C LiPo battery. Be sure to charge the battery as soon as you can; other than binding the P-47 to your DSM2/DSMX transmitter, this baby is ready to fly right out of the box. It has a remarkable amount of thrust available if you need it, but for us, 1/3 to 1/2 throttle was more than adequate. The control surfaces are effective and allow the graceful aerobatics typical of a WW II fighter. The roll rate is a bit slow and requires some coordination with the rudder and elevator to keep from losing altitude. All vertical maneuvers, such as loops, half Cubans, Immelmann turns, and hammerheads can be performed with ease. The fact that you can have an airplane like this, which can be flown in a small field and doesn't require dead-calm winds, is awesome.

QUICK SPECS

WINGSPAN: 19 in.
WING AREA: 69 sq. in.
WEIGHT: 3.35 oz.
WING LOADING: 6.91 oz./sq. ft.
MOTOR INCL'D: Ultra-micro brushed
RADIO REQ'D: 4-channel DSMX- or DSM2-compatible
$129.99 | HORIZONHOBBY.COM

FMS **P-47 Razorback 980mm**

This P-47 is a nice size; it's small but not too small. It comes receiver-ready and is available in either a standard spec or high-speed setup (we reviewed and can recommend the high-speed version). This is one of the better-packaged and preinstalled planes we have had the pleasure of building. As a matter of fact, you could hardly call it "building" at all. The FMS P-47 Razorback is a detailed and durable WW II fighter that takes very little time and effort to assemble. We were really impressed with its stability under less-than-stellar conditions. Half-throttle had a nice steady pull into the wind and still kept it up when turning back with the wind. This Razorback's small size on the ground doesn't mimic its feel in the air. The plane stayed level, even in high winds, and did a good job of holding its line, even in the wind. It has a decent glide and floats much like planes of a similar style. It's very light, so any bit of speed gives the plane a nice controlled descent. The control and power was more than adequate for the type of flying we like to do. It's a great-looking warbird and will definitely put a smile on your face!

QUICK SPECS

WINGSPAN: 38.6 in.
WING AREA: 261 sq. in.
WEIGHT: 35.3 oz.
WING LOADING: 19.5 oz./sq. ft.
MOTOR INCL'D: 3648-KV770 (high-speed)
RADIO REQ'D: 6-channel
$224.99 (HIGH-SPEED SETUP) | FMSMODEL.COM

CARF-Models **P-47 Thunderbolt**

Every part of this kit is flawless, whether it's a piece of hardware or a major component. There is no instruction manual in the box, so you have to download the four dozen or so pages. The surface detail throughout is nothing short of incredible, and when checking against many different documentation sources, it was nice to see that panel lines, hatches, and various other details are in the correct locations. In the air, this Jug tracked pretty darn straight and left the ground after maybe 300 feet. The first landing, rather than being a little warm, was uneventful. The big airplane settles in at a predictable rate, but it did require careful monitoring of throttle and airspeed. At 60 pounds and with those huge flaps, there is an abundance of lift produced but a lot of drag as well. Make no mistake; this is a flying machine—a sophisticated piece of equipment that you would treat like a Ferrari in every way.

QUICK SPECS

WINGSPAN: 110 in.
WING AREA: 2,280 sq. in.
WEIGHT: 59.9 lb.
WING LOADING: 60.64 oz./sq. ft.
ENGINE REQ'D: 120–150cc two-stroke or 250cc four-stroke radial
RADIO REQ'D: 6- to 7-channel
$3,790.00 | CARF-MODELS.COM

"Jug" Spoken Here

More than 15,600 P-47 Thunderbolts were produced from 1941 to 1945 in a wide variety of models, so we'll try to sort them out. The XP-47A was an Allison-powered experiment that led to the initial production P-47B, first flown in May 1941.

Wartime required mass production, initially with P-47C variants featuring a strengthened airframe and some engine changes. The Farmingdale, New York, factory, however, could not meet demands, so Republic opened the Evansville, Indiana, plant producing nearly identical D models. The factory-specific designation mirrored the P-51B/C at two North American factories. For reasons equally obscure, however, the Army dubbed the Curtiss-built Jugs the "P-47G." Meanwhile, tests were conducted on the P-47E with a pressurized cockpit and the F with a laminar-flow wing.

Fighters needed greater range for bomber escort, so a succession of D models accepted external fuel tanks, and late-block razorbacks (D-22 onward) received broader propellers. The classic Jug, of course, was the bubble canopy D, determined after experimental K and L models. The P-47D-25 appeared in early 1944, the blown canopy being selected by Republic test pilot Ken Jernstedt. The D-30 added a ventral fin for enhanced stability.

Other experiments included the liquid-cooled XP-47H, followed by the lighter J model with a more powerful R-2800. Additional bubble D models were produced throughout the war, but two additional versions saw combat. The M, built for additional speed, was delivered to the 56th Fighter Group in England. The last Thunderbolt was the long-range N sent to the Pacific in 1945.–*Barrett Tillman*

The cockpit of the initial test YP-47M, serial 42-27385, clearly showing the K-14-style computing gunsight. (Photo by Brian Silcox)

P-47D 42-75121 flown by Group Commander Col. Hub Zemke, 61st Fighter Squadron, 56th Fighter Group, April–May 1944. (Illustration by Tom Tullis)

Lt. Col. Francis Gabreski, 61st Fighter Squadron, 56th Fighter Group Boxted, England, July 1944. (Illustration by Tom Tullis)

The Planes of Fame Air Museum's Curtiss-built P-47G Thunderbolt (license-built P-47D-10), which is finished and coded UN-M to represent the P-47D flown by 56th Fighter Group ace Walker "Bud" Mahurin. (Photo courtesy of Frank Mormillo)

Hobby People **P-47 Thunderbolt EP**

The P-47 is available as a ready-to-fly model with a 2.4GHz guidance system or as a receiver-ready model to which you just need to add your own radio gear and battery. The brushless outrunner and electronic speed control are premounted and pull the P-47 around with more than a 1:1 power-to-weight ratio. Power off, the P-47 will continue to groove for a few seconds before it starts to drop off a bit. At most, it will exhibit a waggle, but as long as you keep the nose down, it will continue to glide at a normal pace for a bird that is this light. We also like the fact that it can use a small and inexpensive 1600 to 2200mAh LiPo battery pack. This model's flight characteristics are great, and it's the perfect size for flying at the park or in a schoolyard. It easily fits in the backseat of a car. For the price, this plane is a sweet deal.

QUICK SPECS

WINGSPAN: 41 in.
WING AREA: 288 sq. in.
WEIGHT: 36 oz.
WING LOADING: 18 oz./sq. ft.
MOTOR INCL'D: 3536-size outrunner
RADIO REQ'D: 5+-channel
$105.00 | HOBBYPEOPLE.NET

Meister Scale **P-47 Thunderbolt**

The giant-scale P-47 kit from Meister Scale is offered in an all-wood, laser-cut kit as well as a fiberglass fuselage along with the laser-cut wood wing and tail kit. We reviewed the latter, and the quality of the laser-cut parts, the fiberglass fuselage, the supplied lumber, and great-looking plans was outstanding. The Jug handles well on the ground with its widespread landing gear. The engine had enough power to fly the Jug at a little better than scale speeds. This bird flies as if it's on rails, and is smooth and predictable with a wide speed envelope. Because of its higher wing loading, the P-47 is no glider; however, it will glide better than most because of its flat-bottom wing airfoil. Stalls are rather sharp, though, depending on how you approach them; relax the elevator input and add power for recovery. Of course, we chose to go all out with detail on this warbird, and if you want to do the same, it is very easy to do with this kit.

QUICK SPECS

WINGSPAN: 102 in.
WING AREA: 1,900 sq. in.
WEIGHT: 45 lb.
WING LOADING: 55 oz./sq. ft.
ENGINE REQ'D: 3.8-6ci gas
RADIO REQ'D: 6-channel (rudder, throttle, elevator, ailerons, flaps, retracts)
$575.00 (FULL KIT), $450.00 (DELUXE SHORT KIT), $70.00 (PLANS) | MEISTER-SCALE.COM

EXCLUSIVE!

FMS P-47D Razorback 1500mm

The ultimate heavy-metal foam fighter!

BY **RICK BELL** PHOTOS BY **PETER HALL**

The P-47 Thunderbolt was the largest Allied fighter of World War II. Powered by the powerful Pratt & Whitney R-2800 Double Wasp radial engine, the "Jug," as it's affectionately called, could really dish out punishment, and it was strong enough to take it as well.

Lucky for us, FMS has been paying attention to the warbird segment of the market and brings us a new, larger P-47 that has the presence and feel of a giant-scale warbird. This premium model spans an impressive 59 inches and carves a new size niche for warbirds. The plane is molded from a lighter type of EPO 52 foam, and the scale details, which start with the very colorful "Bonnie" trim scheme, are simply amazing. I really like that the molded-in recessed panel lines are finely sculpted and are not the deep gouges that you usually see on a foam model. Other features include a screw-on plastic cowl with a dummy radial engine. The

SPECIFICATIONS

MODEL: P-47D Razorback 1500mm
MANUFACTURER: FMS (fmsmodel.com)
DISTRIBUTOR: Force RC (forcerc.com)
LENGTH: 50 in.
WINGSPAN: 59 in.
WING AREA: 620 sq. in.
WEIGHT: 8.2 lb.
WING LOADING: 30 oz./sq. ft.
RADIO (REQ'D): 6-channel
PRICE: $359.99

GEAR USED

RADIO: Spektrum DX9 transmitter w/ AR7000 7-channel receiver (spektrumrc.com)
SERVOS: Three 9g metal-geared digital and six 17g metal-geared (installed)
MOTOR: Brushless 4258-460Kv with 70A speed control (installed)
BATTERY: Kinexsis 22.2V 6S 5000mAh 30C LiPo (forcerc.com)
PROPELLER: 14x8 4-blade (included)

HIGHLIGHTS

- Excellent scale appearance
- All major components installed
- Shock-absorbing, retractable metal landing gear
- Single-point connection between the wing and fuselage

shock-absorbing metal oleo gear struts are attached to retracts that are designed specifically for this plane. The main wheels have bearings in the hubs, and C-clips retain the wheels on the axles. All the control surfaces use a nylon-type hinge except for the flaps, which use a live foam hinge; all the digital servos have metal gears. The cockpit is completely outfitted with detailed instrument and side panels as well as a painted pilot bust. At the rear, there's a retractable tailwheel and spring-loaded covers. The main retracts also have gear doors and servo-driven inner doors that are timed to open and close as the main gear operates. The included power system uses a powerful 650Kv brushless motor powered by a 6S 5000mAh LiPo battery and a Predator 70A speed control. Hooked up to the included 4-blade 14x8 propeller, the speed of the P-47 is just amazing!

Coming at you for a strafing pass! This was a view the enemy didn't want to see! The P-47 tracks very well with wings level as well as during banked turns.

WITH ITS AMPLE WING AREA AND LONG TAIL MOMENT, THE P-47 IS SMOOTH AND STABLE IN BOTH HIGH- AND LOW-SPEED PASSES.

Field assembly is quick and easy with four bolts that secure the wing panels to the fuselage. Note that the bolts are accessed from inside the fuselage. As you can see, using a cradle to hold the model during assembly/disassembly is a good idea.

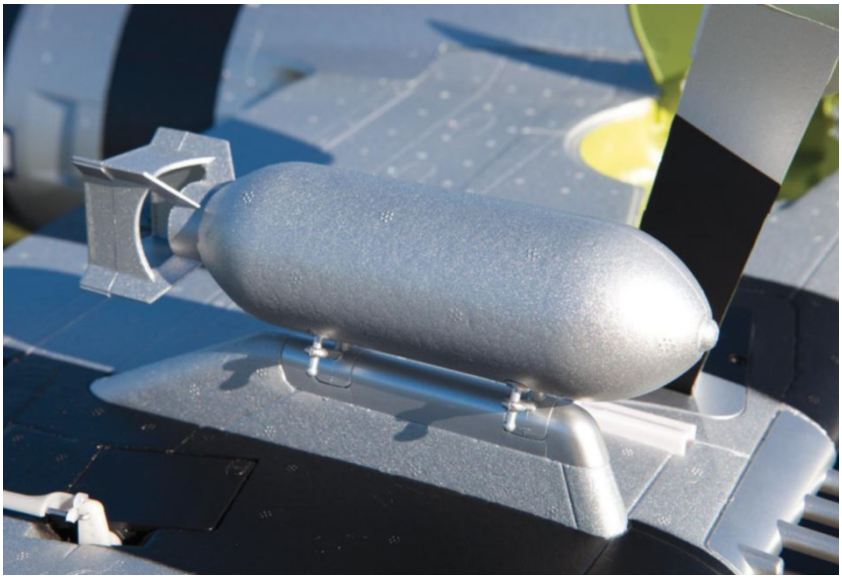
UNIQUE FEATURES

The model I received must have been a preproduction model as it came directly from FMS and there wasn't an assembly manual. I thought this would pose a problem; however, it was easy to figure out what went where and everything worked right from the get-go. The only information that I really needed was for the center of gravity (CG), and this was fortunately posted online.

Assembling the Jug was extremely easy as there are only eight screws required for the airframe along with another four bolts and locknuts for the prop—amazing! All the control surfaces come hinged and use ball links. All the digital metal-geared servos are factory installed with the pushrods attached. The two-piece wing plugs into molded-in pockets in the fuselage and uses two fiberglass tubes that tie everything together. Four very long bolts that are screwed into the wing panels from inside the fuselage keep everything in place. The wing panels feature a single connector on each panel for easy field assembly and disassembly at the field. When you attach the

wing panels to the fuselage, the connector mates to another connector in the fuselage. This completely eliminates all the servo leads coming out of the root of the wing panels. With a total of four leads in each wing panel, this is a most welcome feature. The wing also has the retractable landing gear and navigation lights already installed. When you install your receiver and activate your radio system for the first time, be sure that the landing gear isn't obstructed just in case the gear extends when you turn on the radio. The landing gear also has outer and inner gear doors that completely enclose the gear wells; the same goes for the retractable tailwheel. The horizontal stabilizer is also in two pieces that slide over a fiberglass tube and are then secured with four screws. After they've been installed, the ball links can be adjusted to center the control surfaces.

The 4258-650Kv brushless motor and 70-amp speed control are factory installed and come already wired. The speed control uses the popular EC5 battery connector. The P-47 comes with a scale 4-blade prop, which you have to assemble. Each blade fits into a pocket on the two-piece prop hub, and a screw is then inserted through the hub and base of the prop blades. The back of the prop hub is keyed to the prop adapter on the motor, and the assembly is secured with the screw-on chrome spinner. I used a Kinexsis 6S 5000mAh 30C LiPo battery pack; it fit well on the removable battery tray and provided close to seven minutes of flight time. The recommended CG is 90 to 95mm from the leading edge of the wing where it meets the fuselage. With the battery installed as far forward as it would go, the plane balanced at the rear of the range.



All Decked Out

A nice addition to the FMS P-47 model is the included ordnance, which consists of bombs, machine guns, rocket launchers, and a centerline drop tank. All are molded out of foam and hardly add any weight. I flew the plane several times with all of the ordnance attached, and I didn't notice any changes to the flight performance.

Also, remember to balance the plane upside down, with the gear down.

IN THE AIR

I was really looking forward to flying this beauty as I'm a big fan of the P-47, especially the Razorback version. After loading a battery on the removable battery tray and making a final CG check, the Jug was ready to go. With its wide gear stance, taxiing is easy; you could see the oleos sucking up the bumps in our grass runway. For the first takeoff, I didn't use the flaps, so I held the plane on the ground to let the speed build up before lifting off. Some downtrim

The cockpit is all decked out from the factory with detailed sidewalls, instrument panel, and pilot bust.

The 4-blade prop is comprised of individual blades and a two-piece hub that secures the blades; this makes for easy and inexpensive replacement of the parts. The beautiful screw-on chrome spinner holds the prop assembly to the motor.

and a little left aileron were needed for straight and level flight. Control response was crisp without being overly sensitive, and landings with the flaps were just so smooth!

GENERAL FLIGHT PERFORMANCE

Stability: The Razorback has a solid feel and is an undemanding warbird to fly. With its ample wing area and long tail moment, the P-47 is smooth and stable in both high- and low-speed passes.

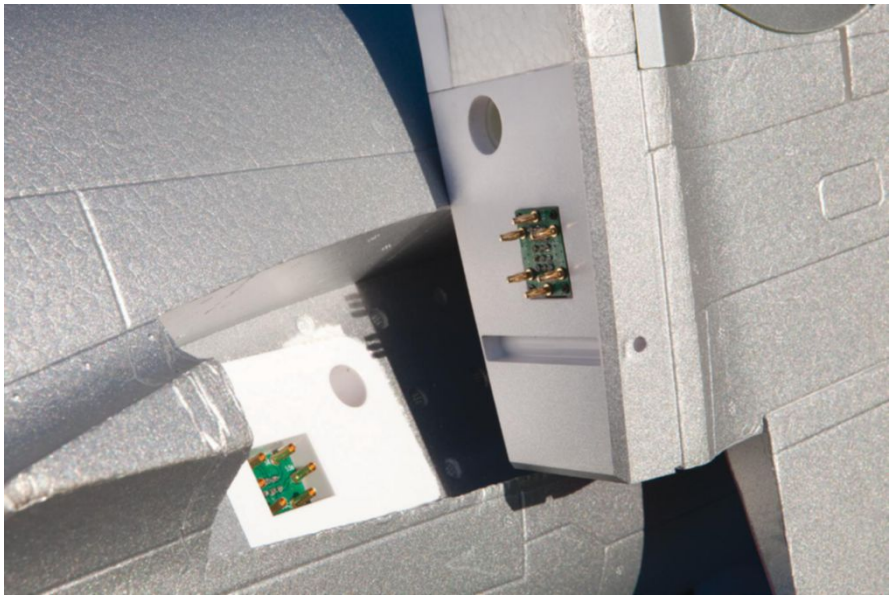
Tracking: With its wide gear stance, the Jug tracks very well on the ground, and minimal right rudder is needed to keep the takeoff straight. In the air, the model tracks smoothly and easily. Adding a little bit of rudder in the direction of the turn helps make turns carve gracefully.

Aerobatics: In a word—awesome! The FMS Razorback is a versatile aircraft, and you can do all the combat maneuvers the full-scale Jug did. Rolls are especially smooth and axial, and there's plenty of elevator authority for smooth high-speed passes with victory rolls. Loops, spins, stall turns—you name it, the Jug can do it!

Glide and stall performance: With its nose pointed into the wind, the model's stall break was gentle to the left or right. Regardless of direction, stall recovery requires just a small application of power to be flying again. With its modest wing loading, landings are undemanding. When using the flaps, a small amount of down-elevator needs to be mixed in; no other retrimming is needed. Glide performance is good as the model has a decent glide ratio with the power pulled back. If you have a dead-stick situation, be sure to keep the nose down and don't use the flaps. You should also wait as long as possible before dropping the gear, if appropriate.

The retractable landing gear is all metal, and the oleos use springs to soak up humps and bumps on those not-so-smooth grass runways. The gear doors are split just like the full-scale plane and lie flat when the gear is retracted.

The battery compartment is spacious and can easily accommodate a Kinexsis 6S 5000mAh 30C battery. The battery is strapped to a tray that slides and locks into place. I used sticky-backed Velcro on the battery and tray to keep the battery from sliding around.



A new feature that FMS incorporated into the P-47 is this six-pin connector. When you slide the wing panels into place on the fuselage, the male/female pins automatically engage. No more servo extension leads to deal with!

PILOT DEBRIEFING

This is a well-behaved and easy-flying warbird, and it is a blast to fly! I think the FMS P-47 is a great choice for a warbird pilot looking to step up to a large-scale model. It looks great on the ground and even better in the air. It has more than enough power and really covers ground quickly.

BOTTOM LINE

With its many features, the FMS P-47 Razorback is a must-have warbird for anyone who loves Thunderbolts. For such a large model, assembly is quick and easy, and parts fit together well. Ground handling is excellent, and it is a very stable flying warbird. Add in all the scale features and you have a warbird that you'll want to take to the field with you every time!

The P-47 Thunderbolt: The Beautiful Brute Lives On

BY **BUDD DAVISSON** PHOTOS BY **JOHN DIBBS**

There's a lot more to the P-47 than simply being a seemingly fat, overweight pugilist surrounded by svelte, muscular-appearing peers on both sides of the fight. Its out-of-place appearance made it the butt of a lot of jokes on its own side. However, to the Axis, whether on the ground or in the air, the arrival of the Thunderbolt was anything but a joke.

One of the unusual features of the P-47—and the secret to its high-altitude performance—hides under the bump on its lower rear fuselage: the turbocharger. Exhaust gases are routed aft to spin the turbocharger, which uses that energy to compress incoming air and ram it into the engine. Most of the Jug's bulbous-belly outline is due to extensive ductwork and plumbing. Many restorations forgo the complications of the turbocharger. (Photo by John Dibbs/planepicture.com)

It's difficult to judge scale in a photo, but the cockpit of the P-47 was big, even compared to other American fighters. In contrast to the cockpits of its adversaries, the difference was almost laughable.

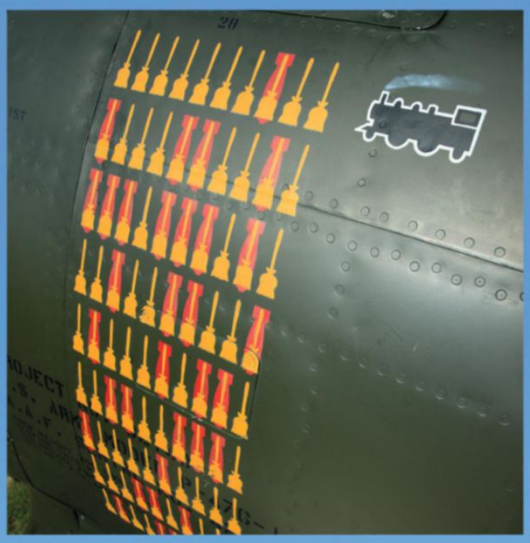
The legendary R-2800, 18-cylinder radial engine was a WW II mainstay but the only radial in single-engine U.S. Army Air Forces (USAAF) combat fighters (P-61s used them), and it used a remote mounted turbocharger rather than a direct-drive supercharger, as they did in U.S. Navy service.

With an aim toward streamlining, the flat, laminated, bullet-resistant glass panel is mounted between the windshield and the gunsight. Bubble canopies put the panel right out front.

In total, worldwide, the Jug accounted for something over 3,600 enemy aircraft in the air, with roughly a 4:1 kill/loss ratio and an unknown, probably much larger number destroyed on the ground.

When turned loose to go down to the deck, the Thunderbolt's ability to hit a designated target and thoroughly destroy it became both legendary and invaluable. The Thunderbolt's heavy armament and capability of carrying a huge ordnance load on hardpoints and pylons came to the fore, and "close air support" took on a whole new meaning. It was the Skyraider of World War II. And there's a good reason the official name of the A-10 Warthog is Thunderbolt II.

Unfortunately, as tough as she was in combat, her survival rate to the present day was looking precarious well into the 1970s. In fact, it was the very last WW II fighter to gain the attention of warbird restorers. This was primarily because Jugs left the U.S. Air Force for the Air National Guard (ANG) almost as soon as the war was over, and the ANG only flew them for a few years. Most of the planes immediately moved to South American air forces. The sight of a



Here, you can see lots of fighter sweeps, with one locomotive left steaming and dead on the track.

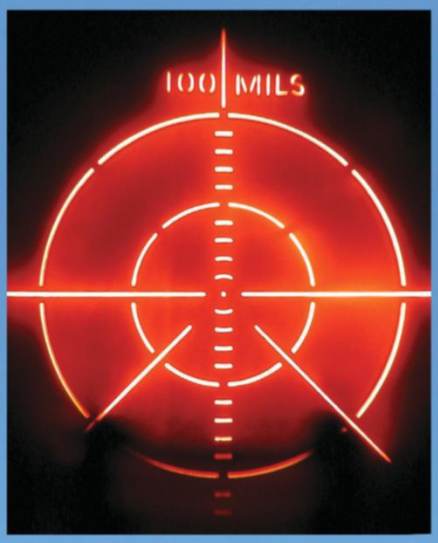
The unit designator (WZ) followed by an individual airplane code (D) was a scheme used mostly by the Eighth and Ninth Air Forces.

P-47 outside of a museum was rare, even in the 1950s. The primary reason that so many Mustangs have survived is that they flew in the ANG until the late '50s, and lots of them were left on U.S. soil, although there were others overseas.

There were practically no Thunderbolt airframes available to restore until the early 1970s. Then, Ed Jurist, who operated Vintage Car Store in Nyack, New York, decided to branch out into airplanes and rescued at least six—possibly as many as nine—complete airplanes from Peru. Since that time, the flying population of the Jugs has continued a slow but steady increase as restorers continue to bring the beautiful brutes back to life.

Although the P-47 was the heaviest and biggest single-engine operational fighter in the USAAF inventory, it was such an easy airplane to land that pilots joked about filling out their paperwork while still on final. This was largely due to the wide landing gear and effective flaps. Note that the gear doors stay open when the gear is down, creating lots of drag, whereas the Mustang's doors close after the gear is lowered, then are dropped after the aircraft is parked.

The serial numbers on all USAAF aircraft remained throughout their careers.



A wide variety of both U.S. and U.K. gunsights were tried in the Thunderbolt, but the USN Mk 8, fixed-reticle unit became standard equipment beginning with the P-47D-20. It was replaced by the K-14A computing sight in 1945. Note the skid ball at the bottom of the reflector glass; the pilot had to keep that centered and the airplane coordinated or the guns wouldn't be pointed where the gunsight indicated. He just "stepped on the ball" to keep it in the middle. (Photos by Budd Davisson)

The word "snafu" (Situation Normal: All Fouled Up) certainly applied to WZ-D, of the 84th Fighter Squadron, 78th Fighter Group at Duxford, England, on December 15, 1944. How it wound up on its belly with no other apparent damage is unknown, but the pilot was Earl Steir. (Photo courtesy of John Dibbs Archives)

SPEED, PROPS, AND POWER!

ENGINE CHOICES AND POWER LOADING EXPLAINED

BY **GREG HAHN** PHOTOS BY **DAVID HART & PETER HALL**

A while back, when I was seriously involved in scale competition, one topic that was often talked about was scale speed, which is usually thrown into the general catchall 10th maneuver in the AMA rule book and as Scale Realism at the Top Gun Scale Invitational. Scalelike speed is not an actual maneuver on your flight card but, rather, something that is judged throughout your entire flight round. And I think because of the need to keep things as simple as possible for both pilots and judges, we won't be seeing speed in a category of its own anytime soon. But one of the most common downgrades that scale pilots receive is for flying too fast. Any way you look at it, speed is a low priority on the score sheet and, in general, is not well understood. And I agree that more emphasis should be placed on the issue of speed because when it's right, everyone notices.

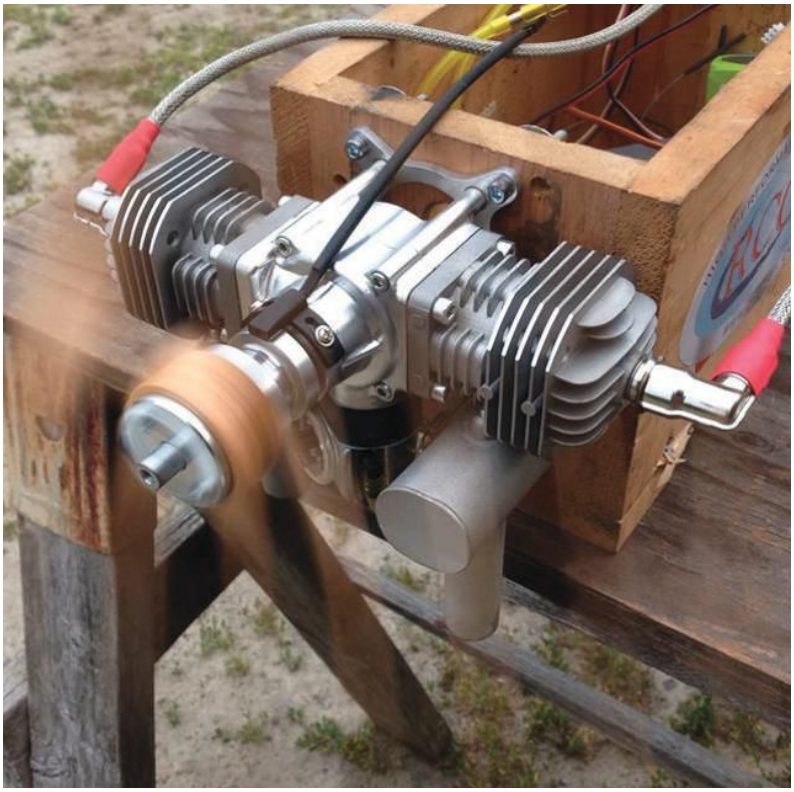
In general, if you give the flight judges what they want (a good smooth presentation flown at the right speed), then they will give you what you want in the form of a high flight score. So here's the rub: If you question the judge and he says that you are flying too fast and you realize you can't do anything about it, you're a hurtin' unit! Let's take a look at achieving more scalelike speeds.

Setting the Stage

Scale speed and flight presentation are issues I like to address in the planning stages of any competition project. Along with three-view drawings, color photos, and color chips, you really should research flight characteristics so that your model can be powered and configured to fly accurately. Of course, the easiest and safest way to go on power is to stick with the plan or the kit manufacturer's or designer's recommendations, which are usually more than adequate for the size and weight of the given model. I like to look at the full-size aircraft's performance figures, particularly the horsepower-to-gross-weight ratio (not overload) to decide on the power requirements of my model. I've used this ratio to configure power for several of my models, and I have found it to be very accurate in providing the proper flight attitude and speed to achieve good flight scores.

The full size P-47 Thunderbolt weighed in at about 18,000 pounds and had an engine rated at 2,300hp. This gave the Jug a power-to-weight ratio of 1:7.8 (7.8 pounds per hp). Your RC Thunderbolt should have the same power loading. (Photo by Budd Davisson)

Pilots who suggest that their 2ci gas engine puts out 4 to 5hp are dreaming and don't understand the math.



For a two-stroke gas engine, figure on 1hp per cubic inch of displacement. Plus, your engine should be properly adjusted to produce optimal performance. I also like to use props that are slightly larger than recommended to help mellow out the throttle response.

Engine Ratings

To use this system correctly, you must first estimate the finished weight of your model. Generally, you'll want to take the expected weight from the plan or kit manufacturer and then figure in your own normal building style: light or heavy. You don't have to get down to the ounce, but try to get within a couple of pounds. You must also know how much horsepower your prospective engine puts out at cruise rpm, or 3/4 power. To keep this simple, a good rule to follow for any naturally aspirated gas or methanol two-stroke engine is to figure 1hp per cubic inch of displacement. Pilots who suggest that their 2ci gas engine puts out 4 to 5hp are dreaming and don't understand the math. For normally aspirated (carburetor, non-turbo-charged) four-stroke engines, figure about 0.7hp per cubic inch.

From here, we now look at the performance figures for the full-size aircraft. Look up the specifics as to gross weight and horsepower of the particular model (B, D, J, etc.) as they will sometimes differ. Divide the horsepower by the weight so that you can determine how many pounds each horsepower is carrying. During World War II, most fighter aircraft had a power-to-weight ratio of about 1:8 (1hp to every eight pounds); bombers were usually around 1:10. If you look at different types of aircraft, you'll find that these numbers are pretty much universal to most piston-engine, propeller-driven aircraft, with the exception of aerobatic types and in a few other special-use planes. Take these numbers and apply them to the model you want to build. This will give you the engine size required to fly that model with as close to scale speed and performance as possible.

When powered by a Zenoah G-38, the popular AT-6 Texan, designed by Nick Ziroli, will perform in a more scale manner and you can carry power all the way to touchdown.

Until you get used to it, a correctly powered model will have a slightly mushy feel and will seem slow to respond to your commands.

Creating the Illusion

To clarify things, here are a few examples. Say that you want to build a big, impressive P-47D Thunderbolt with a span of about 92 inches. The plans call for a finished weight of about 30 pounds and for a minimum power of a 5ci engine or higher. Perhaps you've read a review of the plans-built model in one of your favorite RC magazines, and the builder said that the finished model came out right at 30 pounds and, with a 5.8ci gas engine, would go straight up out of sight and could knife-edge very well. (Oh boy, that's just what I want to see: a giant-scale Jug that flies like an Extra 300—not!) If you're an average builder and you're going to detail this model for competition, you'll want to add about 5 pounds to that finished weight, which would bring it up to 35 pounds. Now look at your documentation for the full-size P-47 and notice that it was powered with a twin-row Pratt & Whitney radial rated at 2,300hp and that it had a gross weight of 18,000 pounds. Divide the full-scale numbers and you'll find that it has a power-to-weight ratio of 1:7.8 or 7.8 pounds per hp.

With this information, take the full-scale ratio and apply it directly to your 35-pound model weight. You'll come up with a required horsepower of about 4.4. This translates to a 4.2 to 4.5ci engine or, for those of you who like to think in metric, a 65 to 70cc engine. Now I understand that the 4.2ci engine, which these numbers recommend for a model of this size and weight, is a long way from a 5.8ci, but we're talking about scale flight performance here. It is difficult, if not impossible, to create the illusion with an overpowered model. The secret here is that if your model is powered correctly, you won't have to create the illusion; the aircraft will do it for you by flying correctly.

My favorite example might scare you a little, but trust me, it works. With a 101-inch span, the Ziroli AT-6 Texan should come out somewhere around 25 pounds. And we all know that that the standard engine for this plane is the Zenoah G-62, which is a 3.7ci engine. The kicker here, however, is that the Texan is a WW II trainer, and the full-scale aircraft had a power-to-weight ratio of a little more than 1:10 (bomber standards), which now means that, at 25 pounds, your model should be powered with a 2.4ci (Zenoah G-38) engine. Contrary to popular belief, a G-38 does fly this model very well; in fact, for scale flight, I'd say that it's almost perfect. The model will use up quite a chunk of runway to get airborne, carry just the right amount of speed at about 3/4 throttle, and go horizon to horizon in a slow roll. It even lands well because you can carry about 35% power with full flaps over the fence instead of having to go to idle on the downwind leg and never really get the approach speed under control (which is the usual case with a G-62 bolted to the firewall). The aircraft is actually flying on its wing and being dragged around by the engine. The only real trade-off is control-surface authority. Until you get used to it, a correctly powered model will have a slightly mushy feel and will seem slow to respond to your commands. It sounds like flying full scale—but isn't that what we want?

Propellers for Scale

For years, I have been catching a lot of guff over my propeller selections. As I said before, creating the illusion of scale flight speeds can be a lot of work, so I want the plane to do as much as possible. As in other forms of RC competition, such as aerobatics or pylon racing, prop selection is very important if you want your beauty to act correctly. The list of recommended props from the engine manufacturers will provide good performance under most conditions, but I have found them to be a tad small for scale performance. I always try new things, but after a bunch of flying, I usually end up using a prop that's one or two steps larger (in pitch, diameter, or both) than what was recommended. I normally overprop so that I can get the airplane to react in ways that can't be easily controlled with the sticks. In other words, bigger props tend to mellow out the reaction time of the throttle and

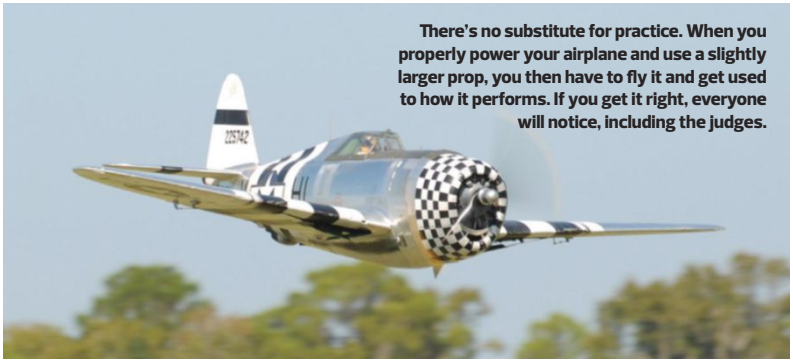
the control-surface sensitivity. The big props also hold rpm down to about 5,300 to 6,000, which is plenty for providing the needed performance and does a good job of controlling sound levels. There's nothing worse than a propeller that should be turning 3,000rpm turning 9,000rpm—and that's at 100% power. If you've watched full-scale aircraft fly, you've probably noticed that nothing happens very quickly. Whether they're in the air or on the ground, airplanes never make sharp jerky movements and there is a certain delay time. By using props that are too big, the model seems to acquire this delay time. I've never had a problem with the actual transition of throttle, but it slows down the transition time. This is very handy at takeoff, causing the model to require less rudder to compensate for P-factor and providing longer, slower takeoff runs that look more scale.

The same holds true for approach speeds and landing, where the big prop creates more drag at lower power settings to make speed control easier when it is most important. Don't be afraid of lost performance with a big prop; of course, there will be a decrease in rpm, but the larger props create more thrust. It just takes longer for the plane to get up on step. Instead of rocketing off the runway in 10 feet, it will take a full lap to reach cruising speed. Be sure to check out my list of displacement and recommended prop sizes. It might be a little mind-blowing but at least give them a try. Keep in mind that, at first, your plane will probably feel sluggish, but I think you'll like the difference when you get used to flying without the sharp edges. Your flight scores will show the positive effects as well.

Always use high-quality, properly balanced propellers. See the table below for suggested prop sizes for engine displacements.

Whether they're in the air or on the ground, airplanes never make sharp jerky movements and there is a certain delay time. By using props that are too big, the model seems to acquire this delay time.

ENGINE DISPLACEMENT	RECOMMENDED PROP SIZE
1.5ci (23cc)	15x10, 16x8, 16x10, 17x10
2.4ci (38cc)	18x6-10, 18x10, 20x6-10, 20x10, 18x10 (3-blade)
2.8ci (45cc)	18x10, 20x10, 22x6-10, 22x10, 20x8-14 (3-blade)
3.7ci (62cc)	22x6-10, 22x8-14, 24x10, 22x6-10 (3-blade)
4.2ci (68cc)	22x10, 24x6-10, 24x8-14, 24x14



There's no substitute for practice. When you properly power your airplane and use a slightly larger prop, you then have to fly it and get used to how it performs. If you get it right, everyone will notice, including the judges.

Practice Flights

We all know that practice makes perfect and that all of us can use more of it, but our flight plans always get lost in the rush. So don't fly haphazardly without a plan. There's an old saying that suggests that scale modelers should get all the points they can on the static judging table because flight points are hard to get. Work out your flight plans ahead of time for your model, then go out and practice, practice, and practice some more. Keep at it so that you can begin to predict what your model will be doing and when. Become familiar with its flight characteristics, and use them to your advantage.

FLYZONE
Rapide EP Glider

A perfect blend of carbon and foam performance soaring

BY **MICHAEL YORK** PHOTOS BY **JENNY & MICHAEL YORK**

You can't see my face as I type this, but despite hours having gone by since my return from a day's test flying, I still have a huge grin. No prize for guessing, but it's due to the new Flyzone Rapide EP performance glider. Those who know me won't be surprised that a sailplane can have that effect on me, but the great-looking Rapide ups the smile ante a bit. It combines the durability of a foamie, the launching simplicity of an EP sailplane, and, thanks to its construction, the performance close to that of a hotliner.

The Rapide will put a smile on anyone's face. It is just the right size for almost any field and compact enough to fit fully assembled in most cars.

A large field really lets you enjoy high-speed low passes. Rock-steady handling makes it comfortable for you to keep it low.

SPECIFICATIONS

MODEL: Rapide
MANUFACTURER: Flyzone (flyzonerc.com)
DISTRIBUTOR: Hobbico (hobbico.com)
TYPE: EP sailplane
WINGSPAN: 60 in.
WING AREA: 364 sq. in.
LENGTH: 42.5 in.
WEIGHT: 39.4 oz.
WING LOADING: 15.59 oz./sq. ft.
RADIO (REQ'D): 4- to 6-channel
POWER: 950Kv motor (installed), 3S 2200mAh LiPo battery (required)
PRICE: $179.99

GEAR USED

RADIO: Tactic TTX650 transmitter w/ TR624 receiver (tacticrc.com)
MOTOR: 35-41 950Kv brushless motor w/ 40A speed control (installed)
BATTERY: ElectriFly 3S 2200mAh 30C LiPo (electrifly.com)
PROP: 13.5x7 folding (included)

HIGHLIGHTS

- Sleek looks and easy-to-see graphics
- Rigid yet durable airframe
- Outstanding performance
- Easy-and-quick assembly

The Rapide is a receiver-ready (Rx-R) kit made out of durable carbon-reinforced AeroCell foam that comes with everything except a receiver and battery. A preinstalled 950Kv brushless motor provides the drive to the large 13.5x7 folding propeller, while the 40A speed control manages the juice flow from a 3S 2200mAh LiPo (that you'll need to supply). Four factory-installed micro servos are already connected to the control servos and are ready for your favorite radio. Also included is a Y-lead for the aileron servos, if you want to keep radio setup simple. Excellent instructions cover every aspect of the minimal assembly as well as the installation of the optional flaps.

Although it's not quite a beginner's plane, intermediates will have no problem stepping up to this exciting and capable performance-oriented glider.

UNIQUE FEATURES

One thing that you'll quickly notice when unpacking the plane is how rigid the whole airframe is, thanks to its extensive carbon-fiber-reinforced plastic internal framework. The Rapide assembly is quite rapid (sorry, couldn't resist that one). You need only a no. 2 Phillips screwdriver to secure the wing and horizontal tail, and a good 1.5mm hex key to tighten the propeller yoke (with a drop of thread-lock). A knife and glue are required only if you decide to install the optional flap kit.

A 10mm-square carbon tube joins the wing halves, which are secured from below using a single screw, while the horizontal stabs slide and clamp onto carbon joiner and control rods (4mm and 2.5mm, respectively). All this makes it easy to take apart if you can't quite fit the assembled 60-inch-span plane into your car.

The upper surfaces of both the wing and tail are fully covered in a graphic sheet, which makes the lifting portions smoother and more efficient than a bare foam surface. It does add a bit of extra weight, but the Rapide is not intended to be a pure sailplane.

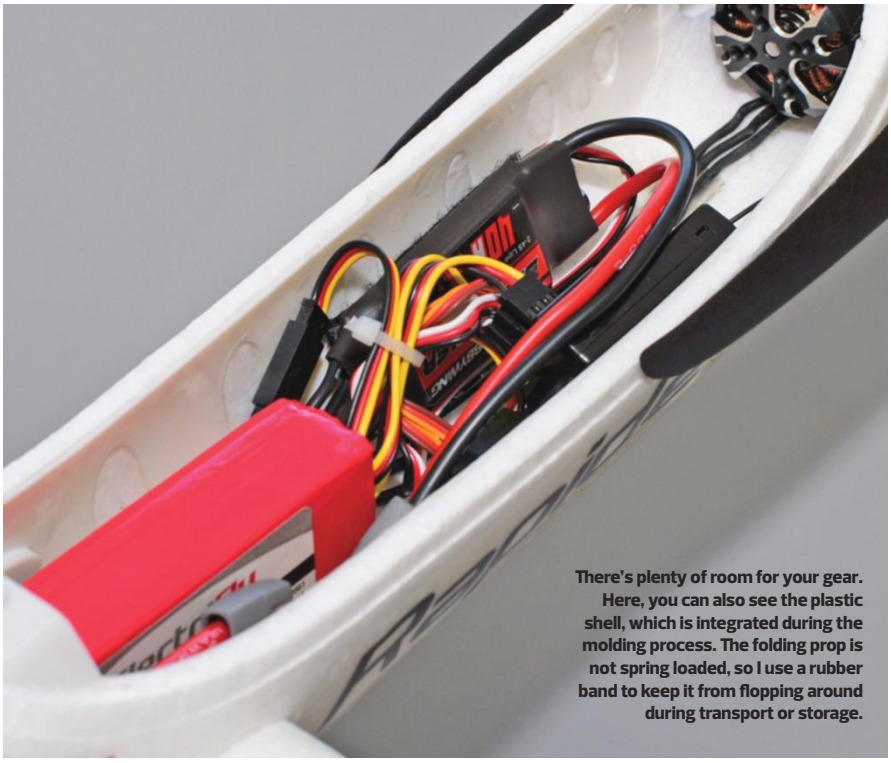
One departure from the typical sport glider is the full-flying stabilizer, which not only is more efficient and

requires less trim adjustment with changes in speed but also allows linkage-free disassembly for transport. Both the rudder and elevator servos are housed in the plastic fin base at the tail for easy access.

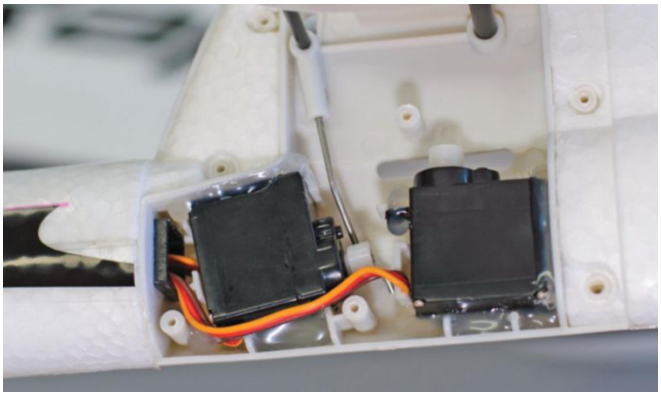
The tinted clear plastic canopy is held in place with a small rotating latch, so there is zero chance that the canopy will fly off even during the most aggressive maneuvers. Despite being a sleek fuselage, there is ample room for your fingers when changing batteries.

Flyzone recommends that you program the radio prior to installing the propeller assembly. This is a good call as an accidental power up on the bench would not be pretty, given the size of the prop. There are cooling holes in the spinner and a small gap between it and the vented firewall, which allows plenty of airflow over the motor, speed control, and battery.

If you do opt for the flaps, it is a very easy process, fully covered in the manual. I have not performed the conversion yet but might try it if the need arises for more speed control during landing. You can always program in some up-aileron to act as spoilers if you need to come down quickly without excessive forward speed.



There's plenty of room for your gear. Here, you can also see the plastic shell, which is integrated during the molding process. The folding prop is not spring loaded, so I use a rubber band to keep it from flopping around during transport or storage.



The tail servos neatly fit into the plastic fin base. You can just make out the square carbon tube ahead of the elevator servo. It runs the entire length of the tail, making it very rigid.

The aileron servos are installed at the factory. Close to the root you can make out the removable blank for the optional flap servo. The flap would start just inboard of the carbon aileron reinforcement.

IN THE AIR

I programmed the radio to the specified throws, and balanced the Rapide in the middle of the recommended center-of-gravity range (done by moving the battery fore/aft). With the recommended ElectriFly 3S 2200mAh battery, it actually came in 4 ounces under the advertised weight.

There is plenty of fuselage beneath the wing to allow a secure grip for hand launching. A slightly nose-high attitude and full power ensured a safe first launch, which was followed by a very brisk climb to altitude. The neutral position mark for the stab was dead on, and the ailerons required only a single click of trim.

There was excellent control authority right down to stall, which means that you can really slow the Rapide down for the approach. As mentioned, if you need a steeper approach, the optional flaps are a good option.

GENERAL FLIGHT PERFORMANCE

Stability: The Rapide is a confidence-inspiring and crisp plane but definitely not a polyhedral wing trainer, so don't expect it to level out on its own.

Tracking: This is a point-and-go plane, which requires almost zero trim correction between various speeds.

Aerobatics: Under power, the Rapide reminds me a lot of a pattern plane and of a fast-flying sloper when the prop is folded back.

Glide and stall performance: It obviously excels in the glide department, with excellent energy retention. Stalls are quite gentle with a quick recovery.

PILOT DEBRIEFING

One thing that I love about molded sailplanes and hotliners is the unmistakable high-pitched whistling howl they make at speed. The Rapide produces that same ear candy, which, of course, means that much of my flying is done at that pace, limiting the flight time to around five to six minutes at constant full power. When I did decide to do some thermal searching, I was able to easily get well over 30 minutes of mixed flying on a single charge. This included many short-burst climbs to altitude, followed by fast-paced power-off aerobatics and low passes. Although not a true thermal plane, I was able to climb out in stronger lift.

The beauty of the Rapide is its versatility (and, of course, its looks). Its size and durability allows me to fly it in areas where I'd be a bit hesitant

The color scheme of the Rapide makes it highly visible in varying conditions. During aerobatics, there is a clear distinction between the top and bottom of the wing, so it's more difficult to get disoriented.

With a little help from the sun, you can see the extensive carbon-and-fiberglass structure, which hides beneath the skin.

THE RAPIDE IS A QUICK-BUILDING AND DURABLE COMPACT SAILPLANE. IT ALLOWS YOU TO AFFORDABLY GET INTO HIGH-PERFORMANCE POWERED SOARING WITHOUT THE USUAL PITFALLS OF COMPOSITE SHIPS.

What Got under Your Skin?

Construction of foam airframes has come a long way. In the early days, "foamie" was synonymous with "flexible." Over time, manufacturing evolved with the requirements and popularity of more-capable sport planes. Sailplanes, however, were somewhat ignored by this trend as most were more oriented toward beginners (read: slower and less stressed). As more people were discovering the enjoyment of fast-moving sailplanes, they also needed to have stiffer airframes.

Rigidity was previously provided by inserting spars and stringers into the foam after it came out of the mold. The new trend is to have the reinforcements integrated during the molding process itself, sort of like a skeleton, allowing for a more accurate airfoil shape (important for efficient soaring) and a better overall rigidity. If you look closely at the Rapide, you can see how the airfoil has zero deformations along its entire surface. The wing is not the only place that benefits from this construction method. Not seen is the large internal square carbon tube that connects the fore and aft fiber-reinforced plastic shell structure; this ensures that the tail stays in line during fast flight. All of this is really starting to blur the lines between high-performance fiberglass planes and the so-called "cheap" foamies. I can't wait to see what the future holds for this segment of our hobby.

to take a more-fragile and expensive sailplane. You can bet it will be my go-to plane for testing out new slope sites.

BOTTOM LINE

The Rapide is a quick-building and durable compact sailplane, which will have any glider-guider smiling. It allows you to affordably get into high-performance powered soaring without the usual pitfalls of composite ships, which can be pricey and somewhat susceptible to damage. Whether you're looking for fast-moving aerobatics (power on or off), thermal hunting, or slope soaring with bailout ability, the Rapide will do it all. I, for one, will be adding to my smile wrinkles with this one.

HOW TO

Choose a Gas-Engine Exhaust System

IMPROVE YOUR MODEL'S PERFORMANCE AND SOUND

BY **KLAUS RONGE** PHOTOS BY **KLAUS RONGE & PETER HALL**

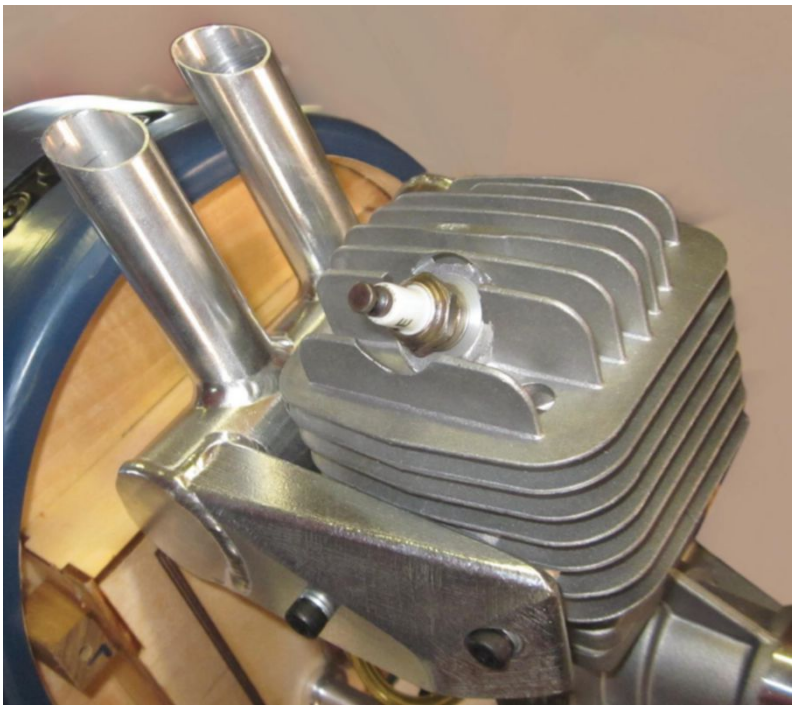
Gasoline-powered two-stroke engines remain a favorite among giant-scale modelers and increasingly for smaller to medium-size models as well. Gas engines are easy and economical to operate, and today's purpose-built RC engines are extremely powerful and reliable. The non-modeling public, however, often finds the noise generated by these engines to be objectionable and have been successful, in many cases, in closing flying fields. A carefully chosen exhaust system can significantly quiet the engine with minimal power loss and, in the case of a tuned exhaust, increase the power.

An RC model in flight generates sound in many ways. The propeller and airframe contribute a significant portion of the noise as witnessed by large-scale electric aircraft, which are far from silent. The engine exhaust, however, is the most significant factor in which the modeler has control. Two-stroke engines expel their exhaust every revolution in contrast to every other revolution for four-stroke engines. The result is a louder and higher-pitch tone. The job of the exhaust system is to dissipate the sound as well as expel the hot gases from combustion.

Broadly speaking, there are two categories of exhaust systems for our engines: mufflers and tuned pipes. Mufflers include stock, Pitts-style, and canister, and they almost always rob the engine of some power. Tuned pipes, on the other hand, quiet the engine while providing a significant boost in performance.

Getting the most performance and the least amount of noise from your giant-scale gas engine–powered airplane depends on a lot of things, and the first place to look is the exhaust system.

Most stock mufflers that come with your engine will do the job, but the performance they offer can vary.



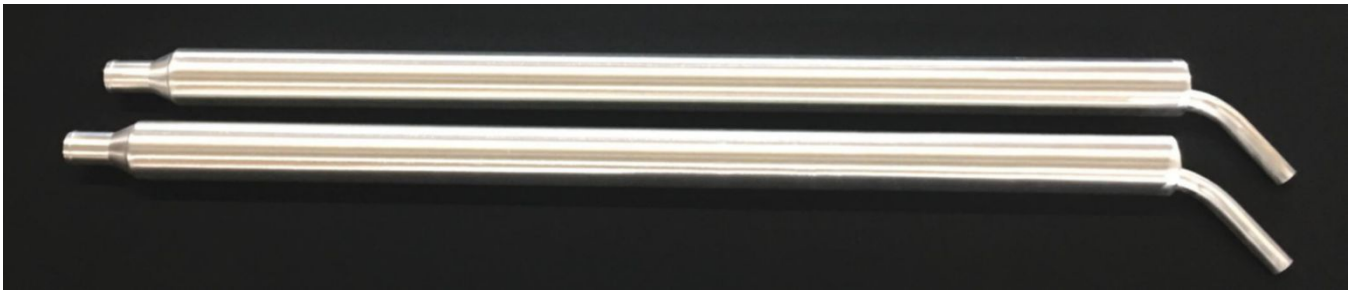
Above: Pitts-style mufflers are a good choice when you don't want to cut a big hole in the side of your cowl. Below: Here, you see the cowl opening for the 55cc-powered Top Flite Corsair. The exhaust setup is neat and compact, and the power increase using a JTEC Pitts muffler is better than that with a stock muffler.

STOCK MUFFLERS

Some gas-engine manufacturers provide a muffler with the engine. The performance of stock mufflers can vary considerably. Some are no more than a piece of metal attached to the engine, while some provide decent sound suppression with minimal power loss. These are similar to the mufflers seen on weedwacker and other household power tools; they generally do little more than direct the sound and exhaust gasses out of the outlet. Stock mufflers do have several advantages, though. They usually have the lightest weight and have a minimal power loss. In addition, they are the best option for smoke systems as they generate the most amount of smoke with no perceptible power loss.

PITTS-STYLE MUFFLERS

Pitts-style or wraparound inverted mufflers are the next step up from stock mufflers. These are usually marginally quieter and also have minimal power loss. Plus, they work great for smoke systems and have the added benefit of the exhaust exiting out of the bottom of the cowl. As with stock mufflers, Pitts-style mufflers are easy to install, with all the components being forward of the firewall.



These tuned-pipe exhausts from JTEC increase power and require a specific header pipe for the engine you are using.

TUNED PIPES

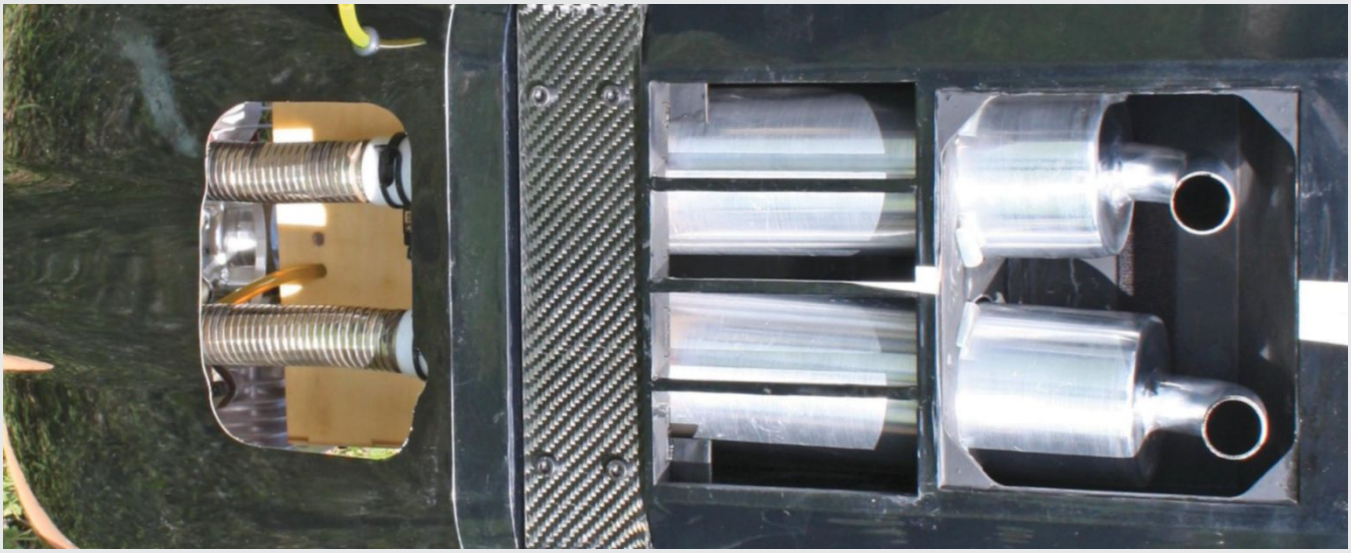
For the ultimate in performance, tuned pipes are the preferred choice because they can increase the engine's top end by up to 500rpm. Tuned pipes mount to the airframe similar to canisters, but the pipe is longer and heavier than the canister. The added weight is typically offset by the increase in power and torque. Invented in Germany as a means of conserving precious gasoline in the late 1930s, the tuned exhaust had the unexpected benefit of substantially increasing the engine's power. The shape of the pipe is carefully designed to make use of the pressure waves generated by the exhaust, which has a similar effect as supercharging the engine. The optimal rpm range is relatively narrow and is affected by the length of the pipe. When the engine is operating in this range, it is said to be "on the pipe."

If you want quiet, use a canister muffler. A flexible coupler is used to connect the canister muffler to the engine's header pipe.

CANISTER MUFFLERS

Canister mufflers are considered to be the quietest but have a slight performance penalty and are heavier than stock or Pitts-style mufflers. A well-designed canister muffler has internal baffles and passageways to quiet the exhaust. In addition, they provide a mellow tone, which is less objectionable and more realistic than the other exhaust types. A canister system consists of a header that mounts to the engine's exhaust flange, Teflon coupler, canister muffler, and muffler mount. The canister is mounted within a tunnel in the airframe, and the header is chosen based on the relative position of the engine-exhaust flange and desired canister position.

Canister mufflers can be ordered with the exhaust outlet located near the front (front dump) or rear (rear dump) of the muffler. There is little difference in performance, and the choice is dictated by the aircraft design or personal preference.



These dual canisters are used with a twin-cylinder engine, and they are both isolated from the model's airframe while still being firmly attached in place.

Installing a Canister Muffler

Mounting a canister exhaust system is not difficult, but there are several potential pitfalls. Incorrectly mounted canisters can lead to cracked headers, increased noise levels, and airframe damage. There are complete exhaust sets available for many aircraft model and engine combinations, which should take the guesswork out of the installation. If you need to install a custom setup, however, these tips should help you avoid some problems:

PLAN THE SYSTEM CAREFULLY. The canister should not put any stress on the header or the header might develop cracks and leaks. Headers come in many configurations to suit the engine mounting and airframe configuration for a custom installation. They also can be obtained with a flexible section for easier mounting. MTW manufactures a double-jointed Knuckle Header (available from Desert Aircraft, desertaircraft.com), which allows the builder to position the canister for a perfect alignment; the header joints are then silver-soldered.

DO NOT HARD-MOUNT THE CANISTER. Hard mounting the canister can also lead to cracks in the header and increased airframe noise. Some aircraft have plywood mounts already installed, but these are easy to make if needed. Plywood mounts should have oversized openings for the canister and be lined with silicon tubing for a friction fit and allow some "float" for vibration dampening. If only one mount is to be used, it should be placed near the center of the canister. Several manufacturers offer canister mounts, making installation even easier.

MAKE SURE THAT THERE IS PLENTY OF AIRFLOW OVER THE CANISTER. Common wisdom states that the exit area should be three times the inlet area, but this is difficult to figure out in real life. Because canisters generate some backpressure and, therefore, more heat, canister-equipped planes typically have one or more open bays or numerous slots on the underside of the airframe. Ensure that there is an opening at the aft end of the canister to allow the hot air to escape.

SECURE ALL WIRING AND ELECTRONICS. If any part of the canister is exposed to the airframe's interior, make sure that no wires or gasoline tubing come in contact with it. Should any of the servo or radio-system wiring get shorted out by the hot canister, the results will not be pretty. Also, remember that aerobatic aircraft can put tremendous G-forces on the components, so make sure that they stay in place.

DLE engines come with their own wraparound Pitts-style mufflers, and they are an excellent choice for sport fliers.

Evolution stock mufflers are made to fit perfectly with Evolution engines, and they come with a protective finish.

When installing canister mufflers, it is important to install them correctly so that they are isolated from the airplane's airframe.

CHOOSING YOUR EXHAUST

Engine size is, obviously, a major contributing factor to noise: The larger the engine, the louder the noise. Larger planes also tend to fly higher, and the noise signature is, therefore, spread out farther. For engines 60cc and under, stock or Pitts-style mufflers are usually adequate for maintaining acceptable noise levels, although this is not always the case. I originally had an inverted wraparound muffler installed on my Evolution 58cc; it produced great power and throttle response but was very loud. I also had a smoke system, and it produced tons of smoke with no ill effect on the engine. It invariably garnered comments about the noise when I flew it. I recently installed a Zimmerman header and Evolution canister, and now it sounds like a different beast; it's much quieter with no noticeable loss in power.

The airframe might also dictate the exhaust setup. Scale and many sport models are, for practical purposes, limited to firewall-forward systems. It would take major modifications to build a tunnel to accommodate canisters or a tuned pipe. In addition, the larger exits required for cooling these systems would usually not look very scalelike. Unless the scale modeler opts for a true-to-scale exhaust, Pitts-style mufflers are the most popular for these types of models.

As in many sports, innovation is driven by competition. IMAC (International Miniature Aerobatic Club) competition features scale aerobatics, and the pilots are awarded a small bonus for acceptable sound levels (except in the basic entry-level class). It is, therefore, no surprise that IMAC pilots go to great lengths to reduce the airplane's noise level while maximizing the engine's performance. I have seen DA-170–powered planes that rival electrics in quietness. Almost all precision IMAC pilots use either carefully selected canisters or tuned pipes. An exception to this is the pilot who also competes in the freestyle rounds of the competition. Some 3D and freestyle pilots find that the midrange on canisters and tuned pipes are difficult to control. These systems do not have the linear power curve found on stock or Pitts-style mufflers, but most pilots will find it negligible.

Nearly all giant-scale aerobatic airframes from the major manufacturers now include a tunnel for canisters or tuned pipes, leaving the choice of exhaust system up to the pilot. Stock or Pitts-style mufflers offer the easiest installation and only require cutting the cowl for the exhaust pipes. Canisters and tuned pipes are not especially difficult to install for these airframes, but consideration must be given to the extra weight and the effect on the center of gravity when they are installed. Tuned pipes have the added complication of tuning the exhaust pipe, which consists of varying the length of the tuned pipe to achieve the optimal power and torque. This is done by sliding the tuned pipe within the Teflon coupler until the desired result is achieved. Typically, the pipe is moved in small increments, and the aircraft is then flown and the performance noted; this is repeated until satisfied.

FINAL THOUGHTS

Even though sound levels can be recorded with a decibel meter, noise is subjective and depends on many factors. A db reading on the ground has little correlation to the aircraft's noise signature in the air. If noise is a concern, then canisters or tuned pipes should be considered if the airframe can accommodate them. They have a deep, mellow tone that most people find acceptable. If these systems are not feasible, then some research will pay big dividends in finding an exhaust system to suit your airframe and engine. ✚

Stock or Pitts-style mufflers offer the easiest installation. Canisters and tuned pipes are not especially difficult to install, but consideration must be given to the extra weight and the effect on the center of gravity.


U.S. AIR FORCE

E-FLITE/HORIZON HOBBY
FPV Manta BNF Basic
Get into first-person view

TEXT & PHOTOS BY **ANDREW GRIFFITH**

First-person view (FPV) has spun off numerous forms of racing, and while most involve small quad rotor drones, there is a growing cadre of fixed-wing pilots using flying wing–style aircraft to FPV race. Enter the Manta from ImmersionRC and the Blade team at Horizon Hobby.

The Manta is constructed of molded Z-Foam and features digital servos and an AS3X stabilized receiver with SAFE (Sensor Assisted Flight Envelope) technology. A Castle Creations speed control, a brushless motor, and an onboard camera with a 5.8GHz video transmitter are all preinstalled.

The Manta can easily be assembled by anyone who can follow a manual, and because it's equipped with a SAFE receiver, the Manta can be successfully flown by anyone comfortable flying a fixed-wing trainer if throttle management is used. If you really open it up, the Manta appears to be flying in the 100mph range and would require more-advanced piloting skills.

The Manta is easily hand-launched, but power should be applied after the model is clear of your hand.

SPECIFICATIONS

MODEL: FPV Manta BNF Basic
MANUFACTURER: Blade/ImmersionRC (bladehelis.com)
DISTRIBUTOR: Horizon Hobby
TYPE: Bind-N-Fly FPV flying wing
WINGSPAN: 43 in.
WING AREA: 338 sq. in.
LENGTH: 14 in.
WEIGHT: 26 oz.
WING LOADING: 11 oz./sq. ft.
RADIO REQ'D: 5-channel DSM2/DSMX
PRICE: $419.99

GEAR USED

RADIO: Spektrum DX18G2 Stealth (spektrumrc.com); AR636 receiver; and two H3050 metal-gear digital servos (installed)
MOTOR: 1800Kv brushless outrunner w/ Castle Talon 35A speed control (installed)
BATTERY: Thrust 35C 4S 1300mAh LiPo
PROP: 5.5x4.5 (included)

HIGHLIGHTS

- Quick and easy assembly
- Great first aircraft for FPV
- Large hatch for easy battery access

Ready to try some FPV with the Manta, my DX18 Stealth, and Walkera FPV goggles.

UNIQUE FEATURES

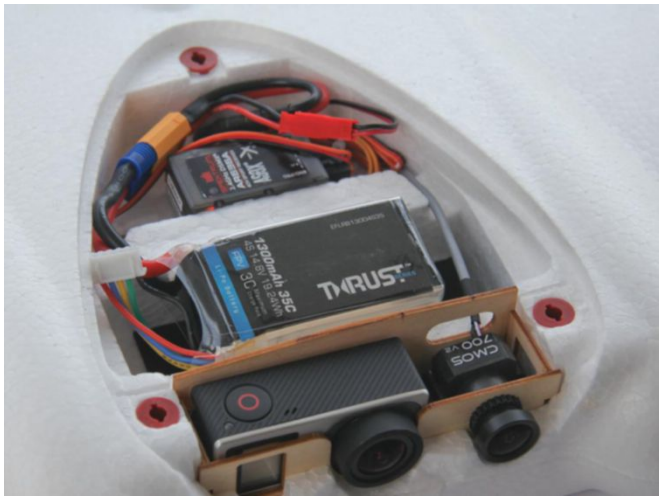
Construction-wise, there is very little left to do but some final assembly. There are only two servos on the flying wing, and the elevon mixing is preprogrammed in the included receiver. The servos, speed control, receiver, and the FPV video transmitter and camera are already installed. The control surfaces are prehinged, with the control horns installed. The motor is wired up but hanging loose, and it needed to be bolted in place with four screws and a few drops of Z-42 thread-lock. The wings are then glued into place with a carbon wing joiner rod. After using a small skewer to punch some holes in the gluing surfaces for the glue to seep in, I coated the wing rod and mating surfaces with 15-minute Z-Poxy. The wings were aligned and secured with low-tack tape and weight bags.

There are two styles of wingtips included: the curved ones seen in the pictures and a generic set for those wishing to customize their own wingtip style. The wingtips are glued in place and then carbon stiffeners are added. After dry fitting the carbon wing stiffeners to ensure that the channels were sized properly, I used a thin bead of medium Zap CA to glue them in place. Customizing your Manta is easy as several sheets of decals are included.

Getting the Manta in the air will require either a 3S or 4S LiPo battery and a full-range 5-channel DSM2/DSMX radio system. Each battery requires a different prop, and propellers for the 4S setup are included; if you want to run 3S, you will need to buy a different prop. A compartment in the front of the equipment bay is form-fitted for a GoPro HERO4 camera.

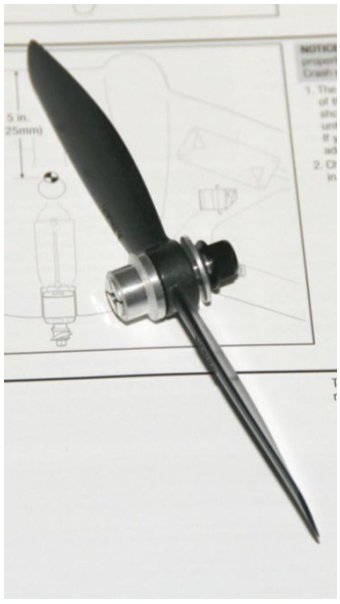
IN THE AIR

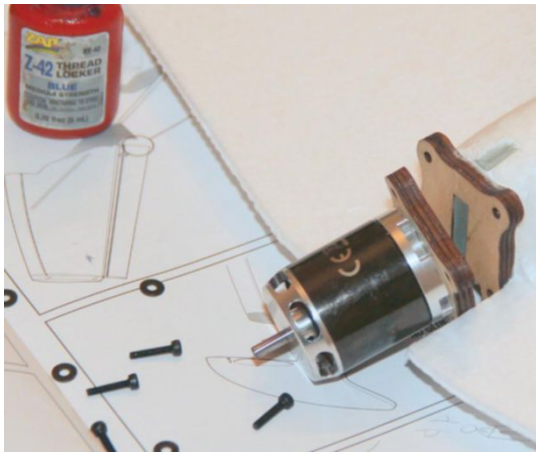
Flying the Manta requires a field larger than you might think for the typical foamie because it's capable of higher speeds than most. The Manta has no landing gear, so it is hand-launched and best recovered by landing on grass. Hand launching is easily accomplished by using the



The radio compartment of the Manta contains the FPV camera and the AS3X receiver. Compartments are provided for the flight battery as well as a GoPro HERO4. The GoPro is optional, but if you fly without one, you will need to add weight up front to get the proper center of gravity.

The Manta comes with a Fat Shark video transmitter installed. I was surprised that, at the range, I had excellent video.





Above: One of the few assembly steps is mounting the motor with the supplied metric hardware. I used Z-42 thread-lock to ensure that it stays put in flight. Left: The Manta comes with the correct propeller for 4S operation as well as the mounting hardware shown. If you choose 3S, you will need to see the manual for the correct prop to use.

THE ABILITY TO FLIP A SWITCH INTO LAUNCH MODE, WHICH ACTS AS A RECOVERY MODE, INSPIRES CONFIDENCE TO TRY YOUR HAND AT FPV FLYING WITH LITTLE RISK TO THE MODEL.

molded-in finger wells on the bottom and giving the Manta a gentle level toss. To avoid cuts from the rear-mounted prop, only advance the throttle when the Manta is clear of your hand.

A plastic skid on the rear keeps the motor safe, but if you land on a paved surface, you won't be doing the foam on the bottom any favors. The Manta is easily landed by pointing it into the wind and approaching with just a little bit of throttle; at two feet, cut the power and add a touch of up-elevator and it should stall flat into the grass.

FPV Flight

If you wish to use the FPV system, you will need a set of Fat Shark or similar FPV goggles—and to do it legally, a tech-class FCC amateur (HAM) radio license. It's a pretty easy test, which has long since done away with the Morse code requirement. I highly recommend flying several flights line-of-sight until you are used to the speed and maneuverability of the Manta before flying it FPV. I also launched and landed the Manta visually.

The Manta proved to be a perfect first FPV platform for me to get comfortable flying with goggles. After a few flights to get used to the Manta, I had someone spot for me while I went "under the hood." With all of the flying-wing functions handled in the AS3X receiver, programming was a snap. Now that I'm used to it, I have a burning desire to try some racing!

GENERAL FLIGHT PERFORMANCE

Stability: The AS3X equipped Manta is remarkably stable. The ability to flip a switch into Launch mode, which acts as a Recovery mode, inspires confidence to try your hand at FPV flying with little risk to the model.

Tracking: Tracking is excellent: The Manta goes where you point it and maintains good tracking at high speeds.

Aerobatics: While aerobatics aren't its primary job, the Manta is quite fun to fly. In Expert mode and full throttle, the Manta rolls like a drill bit and does very tight loops without falling out. The lack of a rudder limits what aerobatics it can perform, but it sure is spirited.

Glide and stall performance: The Manta has a surprisingly wide speed range and glides quite well at low or even no throttle. Stalls merely cause it to fall nose forward and then it resumes flying. Forcing a stall during the landing flare drops the Manta flat into the grass, nice and gently.

PILOT DEBRIEFING

The SAFE-equipped receiver has three flight modes: Launch mode is self-leveling and pitch and roll limiting; Intermediate mode does away with self-leveling, though control is still somewhat limited; and Expert mode is for doing aerobatics.

BOTTOM LINE

The FPV Manta is a very quick and easy build. The hardest part is picking out what decals you want to use out of the several sheets of markings provided. Assembly took me less than two hours, and that included pausing to do the build photographs. The manual is well written, detailed, and easy to follow, and it includes a programming matrix for most Spektrum transmitters.

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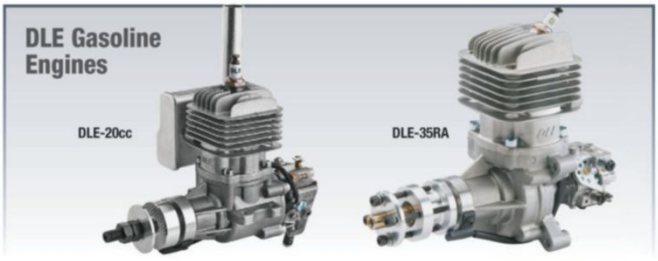

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Team USA wing racer Jeremiah Guelzo and fellow pilots celebrate hosting a successful competition in Hawaii at the end of Drone Worlds 2016.

October saw the culmination of the 2016 Drone Worlds event, and while many came to see the best quadcopter pilots race head to head, something even more exciting, brash, and loud was on show: first-person-view (FPV) wing racing. Such was its impact that it left many asking whether it could be the future of drone racing. We traced the sport's heritage and found out where it's heading.

THE ULTIMAT

FIXED-WING DRONE RACING

TEXT & PHOTOS BY **DAVE STOCK**

Below left: Wings come in all shapes and sizes, and different classes and regulations are now starting to emerge. Below left: Steve Petrotto and Jeremiah Guelzo show off the red, white, and blue of their Team USA wings. Background: A Team Basement Radio Control wing flies amid spectacular Hawaiian scenery.

FIRST-PERSON-VIEW RACING

Flying wings have been a staple of the RC hobbyist circuit for many years. It was, after all, on a wing that drone pioneer, Raphael Pirker, first used baby-monitoring equipment to experiment with real-time video feeds, creating rudimentary FPV in the process. FPV gave wing pilots the opportunity to get inside the cockpit of their craft, and it sparked an entirely new industry as new radio-controlled vehicles built specifically to embrace the FPV revolution emerged. The quadcopter, an exciting newcomer, didn't fit entirely within traditional RC hobbies, but it attracted a new generation of RC fan eager to exploit its best features: speed and agility. From there, racing seemed natural. If you could fly it, why couldn't you race it? In October 2014, the French FPV racing club Airgonay hosted an event in the French Alps that showcased that idea for the masses, proving that FPV racing wasn't only possible but that it was popular, too.

Since then, quadcopter racing has only grown stronger, reaching huge TV audiences, appearing in events in epic locations, such as Dubai and Hawaii, and creating hype in national and international news media. Wing racers, sadly, didn't enjoy the same public profile as their four-propeller counterparts and, facing hostility from the traditional RC community that felt overshadowed by the new kid on the block, weren't assimilated into the scene quite so readily.

A GRASSROOTS START

That, however, didn't stop wing racers. NEFPV, a group of FPV pilots from the northeastern United States, hosted small race events throughout 2014 and, in August of that year, partnered with Team Basement Radio Control (TBRC)—Canada's premier wing designer and manufacturer—to bring wing racing to a wider audience: the North American First Person View (NAFPV) meet, the biggest of its kind. "Whatever the case, wing racing grew slowly throughout 2014 and 2015," says TBRC owner Anthony Watton. But he adds that the popularity of quadcopter racing paved the way for a wider interest.

TE FPV RUSH

1. The international wing-racing scene is growing, and big events, such as Drone Worlds 2016, attract pilots from the United States, Canada, France, Mexico, New Zealand, and Korea. 2. Team USA's James Haley won at Drone Worlds 2016 and is one of the early stars of the sport. 3. Launching wings can be tricky and requires an experienced hand. 4. Flying a wing usually requires a pilot and spotter. 5. Wings are relatively simple craft and require minimal technical know-how, which is part of their appeal.

4

5

The year 2016 saw many more wing-specific events emerge, and for the first time, wings were included in qualifiers for national and international FPV competitions. The NAFPV event, Hawaii State Drone Racing Championships, IDRA Regional West competition, Flying Circus, Wild West Wing Race, and the U.S. Drone Nationals, for example, all held wing-specific races that counted as qualifiers for the international championship event Drone Worlds 2016. This event saw 23 pilots from six countries (the United States, Canada, Mexico, New Zealand, Korea, and France) compete against one another in an international, Olympic-style series. "All of the best pilots were here," explains James Haley, the Team USA pilot who won the competition, alongside fellow American fliers Steve Petrotto and Jeremiah Guelzo, who came second and third, respectively.

A SPECTATOR SPORT

As wing-racing gains momentum, some are hopeful that the new racing class could succeed where quadcopters have failed. "At the moment, [drone racing] is lacking spectators," says Watton. "Quadcopters are too small to follow the action," he says, "but wings could change that. They're big in comparison and easy to see." And for some, they are much more exciting. "Wings are loud, fast, and, when they hit, there's carnage," says Haley. "They dominate spectator attention." And there's another advantage, too. While many pilots prefer not to engage with the commercial aspects of their sport, regarding themselves as hobbyists, most are aware of the potential. "Those large airframes are very easy to see and are a great signboard for corporate sponsors to advertise on," suggests Watton.

Wings are much bigger than quadcopters and much easier to see, which is better for spectators and for sponsorship opportunities.

Scot Refsland, chairman of the Drone Sports Association, congratulates the wing racers at the Drone Worlds in Hawaii. Refsland organized the event and was especially eager to include a wider array of drone sports.

THE RULES ARE SIMPLE

There's clearly traction for wing racing, and pilots, events, and high-profile sponsors continue to get behind the sport. But for any scene to develop, there needs to be a strong amateur level that's attracting new blood. That support came in early 2016 when MultiGP—a growing network of more than 300 local racing chapters around the globe—announced FPV wing-racing rules for the 2016 season. Expecting a long list of rules, specifications, classes, and equipment, potential racers were surprised to discover that MultiGP proposed just three basic rules: Motor size is limited to 2700Kv, rudders are banned, and no electric ducted-fan units are allowed. This stripped-down approach was purposeful, explains MultiGP president Chris Thomas. "You may see holes in these specs where certain airplanes may have an unfair advantage," he says. "I encourage you to exploit these as much and as often as you can." This experimental phase offered pilots the freedom to interpret the rules as they saw fit, and gave local organizers the starting point and flexibility to define the sport further. "You probably just want to have a bit of a play first before you set regulations," explains Thomas Greer, chairman of the British FPV Racing Association. He adds, "See what works [and] what doesn't." Since that first announcement, definitions have been revised to take into account the extensive feedback from race directors. Also, two distinct classes of wing racing emerged: flying wings (single-body aircraft with no tail, and elevons for pitch and roll control) and fixed wings (aircraft with ailerons, elevators, and rudders for control).

A BRIGHT FUTURE

Adding these classes to FPV sporting events might go a long way to assimilating wing racing back into the wider racing community. "Right now, we are the lone wolves at most larger events and have to run a good portion of it ourselves," says Petrotto, adding, "I hope to see a little more focus on wings in the future." And he might not need to worry for long. Canada's biggest FPV racing league, FPV Canada, has incorporated wings into its racing calendar and the already-strong local and state support in the United States is being bolstered by the FPV Wing Racing Association. The latter organization has been set up by wing pilots Alex Greve, Merrill Ross, and Tom McCullough to make "wing racing a highly visible spectator sport" while representing its members interests at all levels. "I see nothing but a bright future," says Watton, and others agree. "I can't wait to see this side of the sport grow in 2017," says Petrotto, adding, "Go buy a wing, fly it, race it, and love it. You'll thank me later."

A typical setup for a day of racing.

YUNEEC Breeze

The perfect social-media flying camera

BY **THE *MODEL AIRPLANE NEWS* CREW** PHOTOS BY **CHERYL MALTBY**

If you are into social media and like posting all of your adventures, then the Yuneec Breeze should be at the top of your next purchase list. Designed for people who want to document their life in movies and photos, the Breeze has some terrific features.

SPECIFICATIONS

MODEL: Breeze
MANUFACTURER: Yuneec (yuneec.com)
TYPE: Sport/camera rig
SIZE: 200mm
WEIGHT: 13.5 oz.
MOTORS: Installed and included
BATTERY: 3S 1150mAh (two included)
SPEED CONTROLS: Installed and included
FLIGHT CONTROLLER: Installed and included
RADIO: Any smartphone or tablet
PRICE: $399.99

HIGHLIGHTS

- Easy to fly
- Quick to get in the air
- Quick posting of images or videos to social media
- Works with smartphone or tablets

HIGHLIGHTS

The Breeze comes fully assembled and only requires downloading the Breeze Cam app along with a quick charge of the batteries (two are included) before getting it in the air. A solid little quad that has the camera gimbal mounted on the back so that it is always facing the pilot and ready to capture photos or video selfies. Its foldable legs keep the props up away from the ground and make it easy for this bird to take off from tall grass. With an all-up weight of 13.50 ounces, the Breeze is easy to take anywhere you are going and will be ready to capture life's moments in minutes.

Any smartphone will give you control of the Breeze through the Breeze Cam app. By using the various flight modes, you will be able to capture complex shots with little or no drone-flying experience. This quad incorporates an optical-flow and infrared-positioning sensors that allow it to hold its position both indoors and out. I can say that all the time we were testing it (both indoors and outside), there was very little drift during flight. The Pilot mode allows you to have manual control over the Breeze, and is so stable and easy to fly that anyone can fly it. In Selfie mode, positioning the Breeze only requires moving the clearly marked sliders to the correct position to guide the quad into the perfect location for a nice shot. Once you've captured that perfect image, just select the photo or video to share, choose which social network you want to use on your phone, and send.

Two battery packs are included with the Breeze, and they are easy to switch in and out.

The Breeze has optical flow and infrared positioning sensors that allow it to hold its position both indoors and outdoors.

AERIAL RECAP

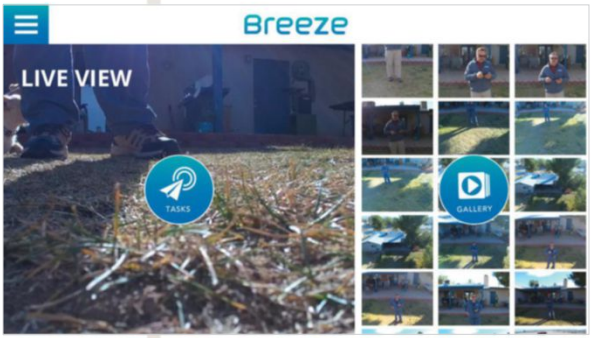
About the only thing easier than sharing images on social media with this quad is flying it, as it is, without a doubt, one of the easiest quads to fly that we have ever reviewed. This is the perfect first drone for anyone, and the best part is that it is loaded with all kinds of great features that are usually only available with higher-priced quads.

You get just about 12 minutes of flight time from each battery. Once in the air, you'll find that this bird is very solid and predictable during the flight. Its smart features offer a number of cool video and photo options. The Selfie mode makes it easy to position the Breeze in just the right spot for the best aerial image or video. Pilot mode gives the operator complete control over the drone, and Orbit mode puts the Breeze into an orbit around you or any external object. Journey mode will fly the Breeze away from you and then back to you, all while capturing nice video. In Follow Me mode, the Breeze uses GPS to track your movement; it did a great job of keeping us in the frame.

DRONES, SOCIAL MEDIA, AND YOU

The Pilot menu has all the controls to make flying the Breeze simple.

The Breeze is designed to make it easy for owners to capture images wherever they may be or whatever they may be doing and share their adventures with the world. It accomplishes this in two ways. First, it is small and light, weighing in at just under a pound and small enough to fit in any backpack. Second, it incorporates the Breeze Cam app with your smartphone, which allows the editing of photos and movies right from the Breeze. In the gallery menu on the Breeze Cam app, you can see the photos/videos stored in the Breeze's memory while the Breeze is on. To post to social media requires downloading the images or video from the drone to your smartphone or computer. This can be accomplished by downloading them directly to the smartphone or through a micro USB cable into the computer. When downloaded to the phone, the Breeze Cam app allows a number of editing functions before you post the images to social media from your smartphone. That's all there is to it: Shoot, download the photos or videos, and post to social media. All of this can be accomplished in a short amount of time (you can even do it while the Breeze is still in the air!).



The opening screen on the app has two sections. Live View lets you control the Breeze and take images. In the Gallery section, it is easy to select an image and post it to social media.

BOTTOM LINE

This is a drone that is made for everyone: It's stable, safe, and easy to fly. If you want a drone that can take good images and allow you to easily share them, the Breeze is the perfect quad for you. +

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Haul Master — SUPER COUPON

3-POINT QUICK HITCH
ITEM 97214
- 2000 lb. capacity
- 27-3/16" Clearance

SAVE $80

SUPER COUPON $89.99

~~$99.99~~ comp at $169.99

Customer Rating

48755380

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ANY SINGLE ITEM

Limit 1 coupon per customer per day. Save 20% on any 1 item purchased. *Cannot be used with other discount, coupon or any of the following items or brands: Inside Track Club membership, Extended Service Plan, gift card, open box item, 3 day Parking Lot Sale item, compressors, floor jacks, saw mills, storage cabinets, chests or carts, trailers, trenchers, welders, Admiral, Bauer, CoverPro, Daytona, Earthquake, Hercules, Jupiter, Lynx, Poulan, Predator, StormCat, Tallgator, Viking, Vulcan. Not valid on prior purchases. Non-transferable. Original coupon must be presented. Valid through 6/7/17.

48723922

SUPER COUPON

FREE
WITH ANY PURCHASE

PITTSBURGH 6 PIECE SCREWDRIVER SET
ITEM 61313/62583/62728
47770/62570 shown

$7.97 VALUE

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48725348

PITTSBURGH AUTOMOTIVE — SUPER COUPON

12 VOLT, 250 PSI PORTABLE INFLATOR
ITEM 61740/63109
63152/4077 shown

SAVE 36%

SUPER COUPON $6.99

~~$9.99~~ comp at $10.99

48729961

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PREDATOR GENERATORS — SUPER COUPON

8750 PEAK/7000 RUNNING WATTS 13 HP (420 CC) GAS GENERATORS
ITEM 68530/63086/69671/63085 shown
ITEM 68525/69677/63087/63088 CALIFORNIA ONLY

SUPER QUIET

- 76 dB Noise Level

Wheel kit and battery sold separately.

Customer Rating

SAVE $469

SUPER COUPON $529.99

~~$599.99~~ comp at $999

48762383

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PITTSBURGH AUTOMOTIVE — SUPER COUPON

1 TON CAPACITY FOLDABLE SHOP CRANE
ITEM 69445/61858
69512 shown

Customer Rating

- Includes Ram, Hook and Chain

SAVE $169

SUPER COUPON $99.99

~~$179.99~~ comp at $269

48741570

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CENTRALPNEUMATIC — SUPER COUPON

2.5 HP, 21 GALLON, 125 PSI VERTICAL AIR COMPRESSOR
ITEM 69091/61454
61693/62803
67847 shown

Customer Rating

SAVE $296

SUPER COUPON $149.99

~~$179.99~~ comp at $446.61

48780135

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PITTSBURGH — SUPER COUPON

16 OZ. HAMMERS WITH FIBERGLASS HANDLE
CLAW: ITEM 69006 60715/60714 | RIP: ITEM 47873 shown 69005/61262

Customer Rating

YOUR CHOICE $3.99

SAVE 77%

~~$4.99~~ comp at $17.99

48726289

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SUPER COUPON

TWO TIER COLLAPSIBLE EASY-STORE STEP LADDER

Customer Rating

SAVE 50%

SUPER COUPON $19.99

- 225 lb. capacity

ITEM 67514 ~~$29.99~~ comp at $39.99

48742393

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US GENERAL — SUPER COUPON

26", 4 DRAWER TOOL CART
ITEM 95659 shown
61634/61952
- 580 lb. capacity

SAVE $269

Customer Rating

SUPER COUPON $99.99

~~$149.99~~ comp at $369.32

48724280

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SUPER COUPON

7 FT. 4" x 9 FT. 6" ALL PURPOSE WEATHER RESISTANT TARP
ITEM 69249/69115/69137
69129/69121/877 shown

SUPER COUPON $2.99

Customer Rating

SAVE 64%

~~$4.99~~ comp at $8.48

48766503

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PITTSBURGH AUTOMOTIVE — SUPER COUPON

RAPID PUMP® 1.5 TON ALUMINUM RACING JACK
ITEM 68053/62160
62496/62516/60569 shown

SAVE $70

Customer Rating

- 3-1/2 Pumps Lifts Most Vehicles
- Weighs 34 lbs.

SUPER COUPON $59.99

~~$79.99~~ comp at $129.99

48738412

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PITTSBURGH AUTOMOTIVE — SUPER COUPON

42" OFF-ROAD/ FARM JACK
ITEM 60668/6530 shown
- 3-1/2 ton capacity

SAVE 23%

Customer Rating

SUPER COUPON $45.99

~~$57.99~~ comp at $59.99

48765578

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SUPER COUPON

10" PNEUMATIC TIRE
ITEM 69385/62388/62409
62698/30900 shown

SAVE 73%

Customer Rating

SUPER COUPON $3.99

Not for highway use.

~~$5.99~~ comp at $14.99

48749760

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CHICAGO ELECTRIC POWER TOOLS — SUPER COUPON

12" SLIDING COMPOUND DOUBLE-BEVEL MITER SAW WITH LASER GUIDE
ITEM 69684 shown
61969/61970

Blade sold separately.

Customer Rating

SAVE $204

SUPER COUPON $134.99

~~$199.99~~ comp at $339

48751007

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drill master — SUPER COUPON

18 VOLT CORDLESS 3/8" DRILL/DRIVER WITH KEYLESS CHUCK
ITEM 69651/62868
62873/68239 shown

Includes one 18V NiCd battery and charger.

Customer Rating

SAVE 65%

SUPER COUPON $16.99

~~$19.99~~ comp at $49

48739492

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UAV education programs reach new heights

BY **MATT BOYD**

We devote pages and pages in every issue of *RotorDrone* to the ever-expanding role that unmanned aircraft systems (UAS) of all types play in our world. Much of our focus is recreational, but increasingly you see us documenting (and celebrating!) the commercial, environmental, and public-safety advancements that drones are ushering in. UAS is far and away the fastest-growing segment of the aviation industry. It's been estimated that its economic impact could climb past $100 *billion* by the year 2020!

Think about that for a second. With that much money almost literally just floating out there, there's an entire generation of technically adept kids coming up through the schools that are looking at drones as a viable career path. And there are plenty of the rest of us with an entrepreneurial streak just dying to take our recreational fascination with all things drone-related into the professional sphere.

What will take all of that ambition and transform it into a reality is education and training, and there are hundreds of institutions out there looking to provide it. I

went looking to see what programs are already in place to help students get their drone careers off the ground. What follows here is by no means comprehensive—there are already far too many institutions offering some form of drone education or technical-training classes to have a hope of listing every one. Rather, we sought to give you a good cross-section of the programs that are out there, with examples of some we felt stood out in some way or another. We've got everything from beginner courses lasting a couple of hours to doctorate-level graduate programs. Some are conducted in person, while other classes are delivered online. Some prepare you for the FAA's Part 107 Unmanned Aircraft General Exam, necessary for anyone looking to use a drone for commercial purposes. Other courses focus on piloting, design, or maintenance. Still others focus on specific skill sets relating to a particular use. In total, I found more than 50 programs from nearly 20 schools. Because I had to organize them somehow, I chose to group them into categories based roughly on the time required to complete the course of study and/or the type of certification or degree awarded. I have highlighted a few notable institutions and created a reference chart for the different programs. I hope you find it useful, and maybe the glimpse of the educational opportunities that are already available to drone enthusiasts of all experience levels will inspire you to take your love of drones to the next level by pursuing one of them.

Embry-Riddle Aeronautical University's UAS club operates their quadcopter on campus in Daytona Beach, Florida, December 1, 2014. (Photo courtesy of Embry-Riddle/David Massey)

FAA PART 107 TEST-PREP CLASSES

The most basic level of organized UAS training courses consist of various test-preparation programs for the FAA's Airman Knowledge Test as part of Title 14, Part 107 ("Part 107" for short)—the certificate required for commercial operation of a drone weighing less than 55 pounds. These classes can range from prerecorded online audio/video tutorial programs, done at the student's own pace, to live-webcast video classes to in-person classes and seminars, ranging from a few hours to several days. Often these types of training are administered by companies, but many are also conducted by continuing-education and/or professional-development departments of academic institutions. Typically these classes have no special requirements or prerequisites, and are geared toward general enthusiasts rather than full-time students. Some in-person programs roll the cost of the test itself into the tuition and are licensed by the FAA to administer it, while others simply prepare you for the exam and leave it to the student to schedule their own. When comparing class format, prices, and times, make sure that you consider what will work best for your schedule and budget.

Relevant schools: Academy of Model Aeronautics; Eye In The Sky UAS Training Academy; Kansas State University; Monroe Community College; Northwest Michigan College

SEMINARS AND SHORT-TERM TRAINING

This is the next step up from the FAA Part 107 test prep and sometimes works in concert with those classes. Most of these seminars are geared toward practical flight-training skills, be they general stick time or task-specific knowledge and techniques like agriculture, cinematography, or emergency response. I have defined these as classes ranging from a several hours to a few weeks, but the common element is that they focus on specific skill sets rather than FAA testing. Again, we have a mix of options delivered in person and online, and prices vary according to class length, intensity, and specialty. Commercial companies, private universities, and public colleges all offer options in this category. Some of these programs offer completion certificates, but these are less important than the practical skills themselves. Pilots will likely not need to take more than one general flight-training class, but some might wish to take multiple courses in specialized skills.

Relevant schools: Academy of Model Aeronautics; Drone University USA; Eye In The Sky UAS Training Academy; Indiana State University; Kansas State University; Monroe Community College; National Drone School; University of Nevada, Reno; Unmanned Vehicle University

Institution Profile

Monroe Community College

Rochester, NY

monroecc.edu

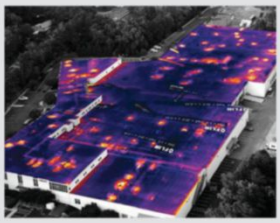
Monroe Community College is an excellent example of a regional school that recognizes the commercial potential of UAVs and has taken a proactive approach to drone education. As part of its Corporate College Economic Development and Innovation Workforce Services Division (which is the fancy way of saying "professional adult education" geared toward us folks with full-time jobs), Monroe offers night classes starting with FAA Part 107 Test Prep as well as an introductory "Learn to Fly" course, which even includes a Syma X5C and a copy of the AeroSIM RC flight simulator. Monroe also sees an important role for drones in the public-service sector, and offers a course for public-safety personnel that introduces them to the various benefits of drone technology in emergency situations as well as their value in training personnel during both drills and post-emergency evaluation.

Institution Profile

Drone University USA

Sacramento, CA

droneuniversityusa.com



COURTESY OF DRONE UNIVERSITY USA

Drone University USA is a commercial UAV education organization that offers an impressive program of specific flight-training and technical skills, including classes on aerial agriculture management, first responder search and rescue, commercial disaster response, and aerial cinematography. Drone University USA contracts with industry professionals to conduct its training seminars and classes. (The cinematography course, for example, is headed by Nick Swartzendruber, whom we featured in the "Drone Cowboys" feature in the Nov/Dec 2016 issue.) Most of these topic-specific courses comprise one to two days at the company's Sacramento facility, but if a client books a full class of 12 students, Drone University USA will take its show on the road and run its training seminars at any appropriate facility that a client specifies. It has also partnered with the Tesla Foundation (teslafoundationgroup.org) to offer, starting in 2017, its base flight-training course at more than 20 colleges and universities across the country.

Institution Profile

Academy of Model Aeronautics (AMA)

amaflightschool.org / **fly-robotics.com**

The AMA has decades of experience in training and support of all kinds of model aircraft, so of course it offers a variety of programs relevant to UAS. In conjunction with Fly Robotics, the AMA offers Part 107 prep and UAS Public Safety courses, but most interesting is its STEM (Science, Technology, Engineering, and Math) Education program for young students. It's a team-based program run through local schools and supported with online curriculum. The ground-school component of the STEM UAS program will prepare students to take the FAA Part 107 test upon completion.

TECHNICAL CERTIFICATIONS

I define this category as longer-term programs that comprise multiple classes or topics but tend to remain more skill-oriented rather than academic in nature. Duration can range from a few weeks up to a full year, and students typically receive a technical certificate upon successful completion. Many of these offerings are comparable to vocational-school programs and commonly share their focus on practical knowledge that has a specific and immediate application in a job environment. There are some technical-certification programs offered entirely online, but the benefits of hands-on training make an in-person class environment start to be more common at this level. Pilots and crew seeking employment with a UAV-oriented business or to establish their own would be candidates for this type of program; the technical certifications would likely be useful in obtaining liability insurance, which a serious commercial drone enterprise would need. Some institutions offer job-placement assistance starting at this level, and if a prospective student has a specific target job in mind, it definitely makes sense to check out what requirements an employer looks for in terms of certification and accreditation.

Relevant schools: Oklahoma State University; Sinclair Community College; Unmanned Vehicle University

PHOTOS COURTESY OF SINCLAIR COMMUNITY COLLEGE

Institution Profile

Sinclair Community College

Dayton, OH **sinclair.edu**

National UAS Training and Certification Center

Located barely 10 miles from Wright-Patterson Air Force Base in the aviation hub that is Dayton, Ohio, it makes sense that Sinclair would be one of the foremost community institutions specializing in technical certifications and associate degree programs relating to the UAS field. How that came to be illustrates an innovative approach to problem-solving that will serve as an excellent example to students enrolled in the program. Back in 2008, the Dayton area—like many such communities—was in the midst of a significant economic downturn, thanks to the contraction of manufacturing and traditional tech industries. Dr. Andrew Shepherd, director of Sinclair's UAS program, told me how Deb Norris, Sinclair's Senior Vice President for Workforce Development, had come back from a trade conference in Israel impressed by that country's leadership role in UAS development; she recognized that Dayton was well positioned, with its rich aviation tradition, technical infrastructure, and human resources, to excel in the UAS field. Sinclair then made the decision to specialize in UAS and has invested heavily in its UAS program. It went so far as to develop the one-of-a-kind, 40-foot-high, 3200-square-foot Indoor Flying Pavilion specifically for UAV flight training and research. The school also worked with Unmanned Solutions Technology, a local business, to develop a custom mobile ground-control station—essentially, a laboratory and control center on wheels—to support UAS training and research in the field. All of that serves students in any of its several one-year technical-certification programs or its two-year associate degree program.

ASSOCIATE OF APPLIED SCIENCE DEGREE PROGRAMS

Think of the programs that confer associate of applied science degrees as those that bridge the gap between technical-certification programs and traditional four-year academic degrees. Community colleges are the most common hosts for associate degree programs, although larger institutions sometimes offer them as well. They can serve as a stand-alone degree, but sometimes the credits can also be applied to a bachelor's program or even transferred to another institution offering a bachelor's program. These programs comprise multiple classes covering a broad range of UAV-related content, from engineering and technical skills to flight training to project management. We've found examples offered in person and online, and an associate degree program typically takes approximately two years to complete.

Relevant schools: Central Oregon Community College; Community College of Beaver County; Sinclair Community College; Troy University

BACHELOR OF SCIENCE DEGREE PROGRAMS

The proliferation of new bachelor's degree programs is the surest sign of the anticipated growth of the UAV field and the professional opportunities it offers. Dozens of universities offer UAS courses as part of their four-year bachelor's programs, and many have expanded their UAS class catalog sufficiently to offer the subject as a concentration or minor. But the most important growth area we've seen is the impressive number of fully accredited institutions—both private colleges and state-level public universities—that now offer degrees specifically in the UAS field. With drones being, by far, the fastest-growing category in the aviation industry, schools are scrambling to develop programs to serve this important technical sector, and the forward-thinking ones are investing to establish themselves as leaders in preparing students for this ever-more-in-demand field. A number of universities have opened multiple tracks within their UAS programs, offering individual focuses on engineering, design, operations, and management. Schools are realizing that most of the specializations available in the full-size aviation industry are applicable to UAVs as well, so look for this trend to only accelerate in the coming years.

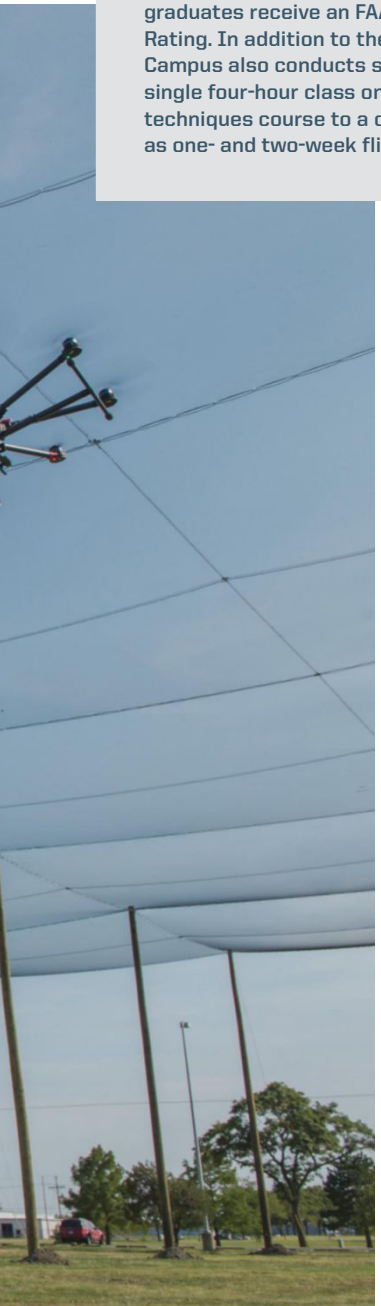
Relevant schools: Embry-Riddle Aeronautical University; Indiana State University; Kansas State University Polytechnic Campus; Kent State University; LeTourneau University; Northwest Michigan College; Oklahoma State University; University of Nevada, Reno

K-State's program includes training on up to 16 different types of UAV, and the Applied Aviation Research Center flies more than 100 missions a year in conjunction with federal agencies, private-sector companies, and other universities, giving lots of hands-on experience in the field.

Kansas State University Polytechnic Campus

Salina, KS **polytechnic.k-state.edu**

Kansas State University is one of a growing category of state schools that have introduced full bachelor's degree programs specializing in UAS as part of its Polytechnic Campus (aka K-State Salina). Dr. Michael Most told me that the origin of his school's UAS program can be traced back to a need to improve emergency response after the extraordinarily destructive tornado outbreak in May 2007. More than 100 storms ripped across the Midwest, including a giant EF5 tornado that destroyed 95 percent of the town of Greensburg, Kansas, and killed 11 residents. In response, Kansas's legislature approved state funds to help develop technology to better deal with such disasters in the future, and K-State Salina's UAS program was founded with a portion of those funds. Of course, the program has grown far beyond that scope in the decade since, and now encompasses full four-year programs, with majors in UAS Flight and Operations and another in UAS Design and Integration. The flight program includes five separate flight-training courses, and graduates receive an FAA Private Pilot license and their Instrument Rating. In addition to the two bachelor's programs, the Polytechnic Campus also conducts several short-term courses, ranging from a single four-hour class on hobbyist-level multirotor safety and flight-techniques course to a comprehensive FAA Part 107 Test Prep as well as one- and two-week flight-training courses.



COURTESY OF KANSAS STATE UNIVERSITY

GRADUATE-LEVEL PROGRAMS: MASTER'S AND DOCTORAL DEGREES

With the expansion of bachelor's programs across the country, growth within the graduate program segment was an inevitable—and welcome!—next step, which we see already picking up momentum. Look for the number and diversity of master's and doctoral programs to grow even faster in the coming years. Graduates of a bachelor's program can typically complete master's work within two years and doctoral work in perhaps a year more, positioning themselves as prime candidates for top-level job opportunities across the UAS field. Interestingly, when it comes to graduate-level programs, online seems to be as much the norm as in-person classes, so it should be possible for graduates with bachelor's degrees to continue their education with greater flexibility.

Relevant schools: Embry-Riddle Aeronautical University; Oklahoma State University; Unmanned Vehicle University

COURTESY OF EMBRY-RIDDLE AERONAUTICAL UNIVERSITY

Institution Profile

Embry-Riddle Aeronautical University

Daytona Beach, FL; Prescott, AZ

erau.edu

No private university embodies more aviation tradition and prestige than Embry-Riddle, and it was one of the first universities to translate its full-size aviation bachelor of science and master of science degree programs into UAS equivalents. Currently, Embry-Riddle offers four such program categories: two each at the bachelor's and master's level. What is interesting is that the school offers both either in person or online and at Embry-Riddle's worldwide campus network. A bachelor's in UAS Science is available at either the Daytona Beach or Prescott campus; the master's in Unmanned & Autonomous Systems Engineering is available at the Daytona Beach campus only. A bachelor's in UAS Applications and a master's in Unmanned Systems are available worldwide. The latter two obviously make the programs especially appealing to prospective students who might not have an accredited degree program near where they live. Both sets of programs emphasize not only flight and technical proficiency but also development, application, and management of UAS programs, plus the policies and regulations necessary to stay relevant in the expanding field.

Institution Profile

Unmanned Vehicle University

Phoenix, AZ

uxvuniversity.com

Unmanned Vehicle University proudly touts itself as the first university to be licensed to grant master's and doctoral degrees in Unmanned Systems Engineering using curriculum delivered totally online, and remains one of very few doctorate-level degrees available in UAS in any form. UVU emphasizes the industry experience of its instructor staff—ranging from military to commercial, adding up to a combined 500 years of UAV operations' experience to draw from—offering students more real-world knowledge than most other institutions of any size. Graduates from these programs will be well positioned to apply for positions as chief engineers, researchers, systems engineers, and engineering managers in the UAV field. In addition to its graduate-level programs, UVU also offers more traditional short-term training courses focusing on flight training and FAA Part 107 test prep as well as technical-certification programs for UAS Project Management.

Students in UVU's postgraduate programs will be well positioned to work on projects like professional aerial cinematography, now being utilized in everything up to and including Hollywood feature films.

COURTESY OF UNMANNED VEHICLE UNIVERSITY

Drone Education Programs by Category

INSTITUTION	CATEGORY	PROGRAM NAME	LOCATION	TYPE OF ATTENDANCE
Academy of Model Aeronautics	Test prep	FAA Part 107 Preparatory Course	Various	Online
Eye In The Sky UAS Training Academy	Test prep	FAA Part 107 Test Prep	Nevada Institute of Autonomous Systems (NIAS), ND, NY, and TX Test Sites	In person
Kansas State University	Test prep	sUAS Commercial Pilot Training (Part 107)	K-State Polytechnic Campus, Salina, KS	In person
Monroe Community College	Test prep	Remote Pilot Knowledge (FAA Part 107) Test Preparation Class	Rochester, NY, campus	In person
Northwest Michigan College	Test prep	Remote Pilot Ground School and FAA Test Prep	Traverse City, MI, campus	Online
Northwest Michigan College	Test prep	Remote Pilot Ground School and FAA Test Prep with Individual Instruction	Traverse City, MI, campus	Online
Academy of Model Aeronautics	Seminar/Short-term training	UAS 4 Public Safety Course	Various	In person or online
Academy of Model Aeronautics	Seminar/Short-term training	UAS4STEM Search & Rescue Challenge	Various	In person or online
Aviation Seminars	Seminar/Short-term training	UAS/UAV/Drone Ground School	55 cities across the U.S.	In person
Drone University USA	Seminar/Short-term training	Specialized Training Courses in Agriculture Aerial Vegetation Management, First Responder/Search and Rescue, and Commercial Disaster Preparedness/Response	Sacramento, CA	In person
Drone University USA	Seminar/Short-term training	Small UAV/Drone Advanced Aerial Cinematography Training Course	Sacramento, CA	In person
Drone University USA	Seminar/Short-term training	Small UAV/Drone Commercial, Remote Pilot Training & Certification Course	20 affiliate campuses through Tesla Foundation	In person
Eye In The Sky UAS Training Academy	Seminar/Short-term training	Training Courses in Fixed-Wing UAS, Rotary UAS, and Hybrid UAS	Reno, NV (Silver Springs Airport); Alamosa, CO (Leech Airport); Carrabelle, FL; PA; and MI	In person
Indiana State University	Seminar/Short-term training	FAA Part 107 Course	Terra-Haute, IN	In person
Indiana State University	Seminar/Short-term training	First-Responder Training	Terra-Haute, IN	In person
Kansas State University	Seminar/Short-term training	sUAS Fixed-Wing or Multirotor Course	K-State Polytechnic Campus, Salina, KS	In person
Kansas State University	Seminar/Short-term training	sUAS Multirotor Hobbyist Course	K-State Polytechnic Campus, Salina, KS	In person
Monroe Community College	Seminar/Short-term training	Introduction to Small Unmanned Aerial Systems/Learn to Fly (sUAS)	Rochester, NY, campus	In person
Monroe Community College	Seminar/Short-term training	Introduction to Small Unmanned Aerial Systems—Public Safety (sUAS)	Rochester, NY, campus	In person
National Drone School	Seminar/Short-term training	Online UAV Flight Training Course	Online	Online
University of Nevada, Reno	Single course	UAS Flight Coordinator Course	Reno, NV, campus	In person
Unmanned Vehicle University	Seminar/Short-term training	UAV Pilot Training Program	Phoenix, AZ	Online
Oklahoma State University	Technical certification	Unmanned Pilot	Stillwater, OK, campus	In person or online
Sinclair Community College	Technical certification	UAS First Responder, Geographic Information Systems, and Precision Agriculture Certification	Dayton, OH, campus	In person
Sinclair Community College	Technical certification	Unmanned Aerial Systems	Dayton, OH, campus	In person
Unmanned Vehicle University	Technical certification	UAS Project Management	Phoenix, AZ	In person
Central Oregon Community College	Associate degree	Unmanned Aerial Systems	Bend, OR, campus	In person
Community College of Beaver County	Associate degree	Unmanned Aerial Vehicle	Monaca, PA, campus	In person
Sinclair Community College	Associate degree	Unmanned Aerial Systems	Dayton, OH, campus	In person
Troy University	Associate degree	Unmanned Aerial Systems	Troy, AL	Online
Embry-Riddle Aeronautical University	Bachelor's degree	Unmanned Aircraft Systems Science	Daytona Beach, FL, and Prescott, AZ, campuses	In person
Embry-Riddle Aeronautical University	Bachelor's degree	Unmanned Aircraft Systems Applications	Worldwide campuses and online	Regional and online
Indiana State University	Bachelor's degree	Unmanned Systems Technology	Terra-Haute, IN	In person
Kansas State University	Bachelor's degree	UAS Design and Integration or Flight and Operations specializations	K-State Polytechnic Campus, Salina, KS	In person
Kent State University	Bachelor's degree (minor)	Unmanned Aircraft Systems	Kent, OH, campus	In person
LeTourneau University	Bachelor's degree	Remotely Piloted Aircraft Systems: Electronics (ARVE), Pilot (ARVP), or Technician (ARVT) Concentrations	Longview, TX, campus	In person
Northwest Michigan College	Bachelor's degree (minor)	Unmanned Aerial Systems (UAS, UAS 1, UAS 2)	Traverse City, MI, campus	In person
Oklahoma State University	Bachelor's degree	Unmanned Pilot	Stillwater, OK, campus	In person or online
University of Nevada, Reno	Bachelor's degree (minor)	Unmanned Autonomous Systems	Reno, NV, campus	In person
Embry-Riddle Aeronautical University	Master's degree	Unmanned & Autonomous Systems Engineering	Daytona Beach, FL, campus	In person
Embry-Riddle Aeronautical University	Master's degree	Unmanned Systems	Worldwide campuses and online	Regional and online
Oklahoma State University	Master's degree	Unmanned Systems Engineering	Stillwater, OK, campus	In person
Unmanned Vehicle University	Master's degree	Unmanned Systems Engineering	Phoenix, AZ	Online
Oklahoma State University	Doctoral degree	Unmanned Systems Engineering	Stillwater, OK, campus	In person
Unmanned Vehicle University	Doctoral degree	Unmanned Systems Engineering	Phoenix, AZ	Online

Please note that while the information on this chart was accurate to the best of our knowledge at time of publication, schools change program details frequently. Check with a specific institution for its most up-to-date program info.

LENGTH	ESTIMATED COST	PREREQUISITES	TYPE OF CERTIFICATION UPON COMPLETION	SHORT URL
4-6 hours	$249 ($174 for AMA members)	None	FAA Part 107 Certificate	fly-robotics.com/ground-school
3 days	NA	None	Certificate of Completion	eyeintheskyuas.com
5 days (40-hour course)	$1,400	None	FAA Part 107 Certification	polytechnic.k-state.edu
6 hours (2x 3-hour evening classes)	$495, plus test fee	None	FAA Part 107 Certification	monroecc.edu
Self-paced	$299	None	UAS Operator Certification	nmc.edu/drone
10 hours, plus self-paced	$599	None	UAS Operator Certification	nmc.edu/drone
3 days	$1,295	Public Safety Officers	FAA Part 107 Certificate	fly-robotics.com/public-safety-2
Self-paced	$2,495	Middle/High school + adult sponsor	FAA Part 107 Certificate	uas4stem.org
2 days	$429	None	Certificate of Completion	avsem.com
1 day (8 hours) each	$1,299 each	None	Technical Certificate	droneuniversityusa.com
2 days (16 hours)	$1,599	Requires that students own equipment and have basic flying skills	Technical Certificate	droneuniversityusa.com
2 days (16 hours)	$2,199		Technical Certificate	droneuniversityusa.com
5 days	NA	None	Certificate of Completion	eyeintheskyuas.com
2-day seminar	$120	None	FAA Part 107 Certificate	indstate.edu/technology/ums
2-week training class	NA	None	NA	indstate.edu/technology/ums
5 to 9 days (40-72 hours)	$3,100 to $4,500	FAA Part 107 certificate	Kansas State University Fixed-Wing Course Achievement Certification	polytechnic.k-state.edu
1/2 day (4-hour course)	$200	Under age of 14 must have permission of parent or guardian	NA	polytechnic.k-state.edu
12 hours (4x 3-hour evening classes)	$995	None	Training Certificate of Completion	monroecc.edu
16 hours (2x 8-hour day sessions)	$1,350	Open to public-safety personnel	Training Certificate of Completion	monroecc.edu
Own pace	$199	None	Certificate	nationaldronetraining.com
3 credits/1 semester	Varies	Undergraduate junior or senior	NA	unr.edu
52 hours	$3,500	16 years of age	Certificate of Completion	uxvuniversity.com
NA	Varies	Varies	Technical Certificate—Unmanned Pilot	unmanned.okstate.edu
32 weeks (16 credit hours)	$1,684 + $720 books/supplies	None	Technical Certificate	sinclair.edu
1 year (33 credit hours)	$3,417 + $1,485 books/supplies	None	Technical Certificate	sinclair.edu
16 credit hours (4x 4-credit courses)	$400/credit ($6,400 total)	High-school degree or equivelent	Certificate of Completion	uxvuniversity.com
Multiclass degree; 95 credits	$93 to $256/credit	None	Associate of Applied Science	cocc.edu
2 years (65 credit hours)	Varies	NA	Associate of Applied Science	ccbc.edu/UAV
2 years (62 credit hours)	Varies	NA	Associate of Applied Science	sinclair.edu
6 classes (2 per semester)	$338/credit	NA	Associate of Applied Science (also a bachelor's degree minor)	spectrum.troy.edu/uas
122 credits (4 years)	Varies	Embry-Riddle admission standards	Bachelor of Science	erau.edu
120 credits (4 years)	Varies	Embry-Riddle admission standards	Bachelor of Science	erau.edu
4 years	Varies	Indiana State admission standards	Bachelor of Science	indstate.edu/technology/ums
4 years	$357.50/credit (KS resident); $828/credit (nonresident)	K-State admission standards	Bachelor of Science(Flight Ops specialization also receives FAA Private Pilot License with Instrument Rating)	polytechnic.k-state.edu
16 credits minimum, 11 classes offered	Varies	NA	Bachelor of Science (Minor)	kent.edu/caest
4 years (126 to 132 credit hours)	$27,930/year	Varies	Bachelor of Science	letu.edu
4 years	Varies	NA	Bachelor of Science (minor)	nmc.edu
4 years	Varies	Varies	Bachelor's degree—Unmanned Pilot	unmanned.okstate.edu
18 credits (six 3-credit courses)	Varies	NA	Bachelor of Science (minor)	unr.edu
1.5 to 2 years (30 credit hours)	Varies	Bachelor's degree	Master of Science	erau.edu
1.5 to 2 years (36 credit hours)	Varies	Bachelor's degree	Master of Science	erau.edu
1.5 to 2 years	Varies	Bachelor's degree	Master's degree in Unmanned Aircraft Systems Engineering	unmanned.okstate.edu
1.5 to 2 years (36 credit hours)	$400/credit ($14,400 total)	Bachelor's degree in any field from an accredited college/university	Master's degree in Unmanned Systems Engineering	uxvuniversity.com
3 years	Varies	Bachelor's degree	Doctoral degree in Unmanned Aircraft Systems Engineering	unmanned.okstate.edu
3 years (60 credit hours)	$400/credit ($24,000 total)	Bachelor's degree in any field from an accredited college/university	Doctoral degree in Unmanned Systems	uxvuniversity.com

RISE Vusion Extreme FPV Race Pack

Speed through the gates with this all-inclusive racer

BY **MIKE GANTT** PHOTOS BY **JOHN REID**

Your first time drone racing can be challenging to say the least, but it is also addictive. The wise folks at RISE have a menu of racing offerings, and the Vusion is their newest entry. It includes everything you need to join the racing craze.

SPECIFICATIONS

MODEL: Vusion
MANUFACTURER: RISE (explore-rise.com)
TYPE: Racing quad
SIZE: 250mm
WEIGHT: 17.9 oz.
MOTORS: Brushless, 2280Kv (included)
BATTERY: RISE 3S 1500mAh (included)
SPEED CONTROLS: Brushless, high-frequency with OneShot 125 programming (included)
RADIO: RISE 2.4GHz 6-channel (included)
PRICE: $350.00

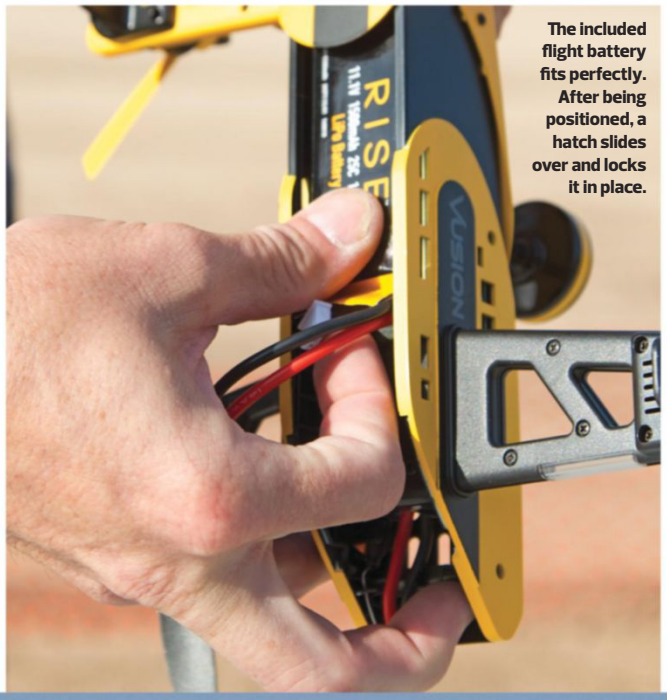
HIGHLIGHTS

- Nothing else to buy
- Fast out of the box
- Monitor or goggle FPV
- 5.8GHz Raceband-ready

UNIQUE FEATURES

A high-grade injection-molded plastic is used for construction, and there are LED lights on the arms. The arms themselves are quickly and easily replaceable, and if you know anything about racing quads, that feature is extremely welcome. The power system is quite adequate with 2280Kv outrunners paired with OneShot ESCs. A 600 TV-line camera is smartly installed into the airframe and pops up on demand with a slight push. Said camera is prewired up to an 8-channel Raceband video transmitter and supports up to a 32G micro SD card for in-flight recording. An LCD monitor is also added and can be attached to the included 2.4GHz 6-channel transmitter or installed into the included goggles for instant viewing in real time. The monitor also accepts a 32G memory card for first-person-view (FPV) recordings. A 3-cell 1500 LiPo flight pack also arrived in the Vusion's box of goodies, and it even has a mating plug soldered on. There is also a balance charger thrown in with an AC adapter, a spare set of propellers, and four AA batteries for the radio. Another included feature worth a shout-out is the lost-aircraft locator, which will beep in the event of a crash or out-of-sight landing.

The Vusion is available with a 25mW or 200mW video transmitter (ours came with a 200mW). Each arrives prewired to the pop-up camera.



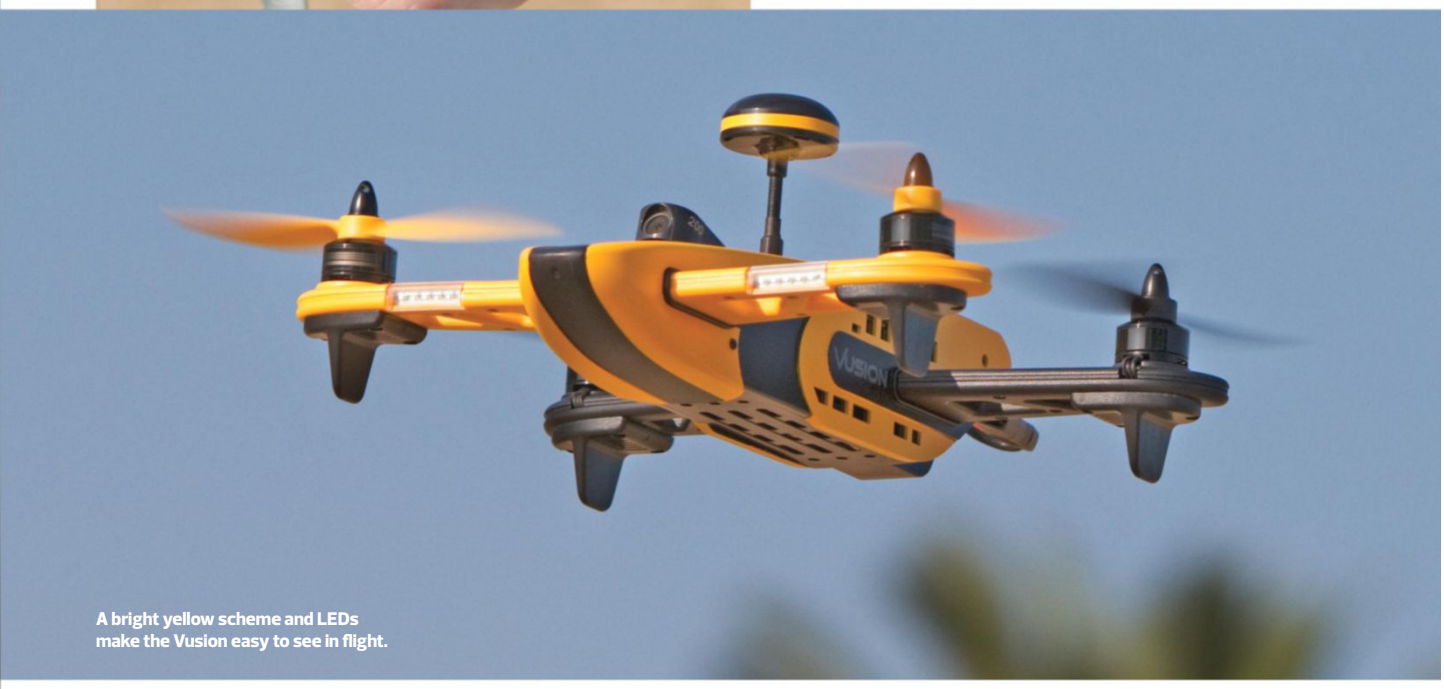
The included flight battery fits perfectly. After being positioned, a hatch slides over and locks it in place.

IN THE AIR

A short and simple calibration process has the Vusion up and flying within a minute. Moving the left stick to the right/left while the throttle is at the lowest setting arms/disarms the motors. The guidance transmitter has dual rates, which allows for more stability or agility as well as a switch for flight modes. Mode 1 is the most stable, features self-leveling, and allows the aircraft to tilt up to approximately 30 degrees. Mode 2 also has the auto-level attribute but now permits up to a 45-degree tilt. Mode 3 disables the self-level feature and lets the model fly at any angle and perform aerobatics. All modes feel solid, and this tells the pilot that the model is tuned quite well from the factory. When employed, the self-level integrant quickly repositions the quad from your tilted flying angle without being jerky or bouncy. In "full acro" mode, the Vusion can really rip around and cut some good corners. As for speed, there is plenty of it; this racer is no slouch for a 3S machine. Depending on the aggressiveness of your flying style, you can expect flight times of about four to five minutes with the included battery.

BOTTOM LINE

The hobby/sport of drone racing is exciting and challenging. Acquiring all of the equipment that plays nicely together can be a chore in itself but not with this setup, which is basically plug-and-play. There is no assembly, except for screwing in the video-transmitter antenna; that is something you always need to do before powering one on.



A bright yellow scheme and LEDs make the Vusion easy to see in flight.

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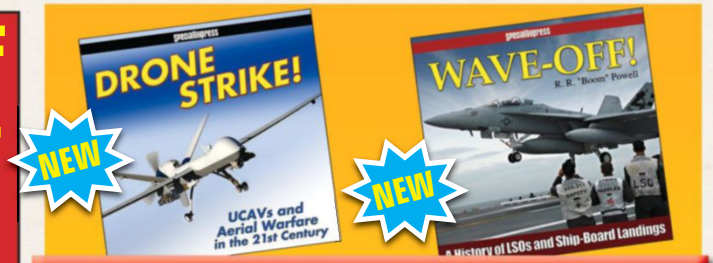

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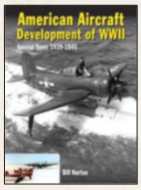

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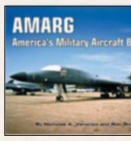

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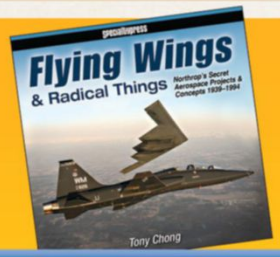

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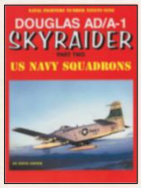
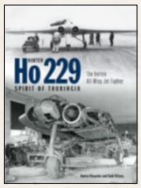
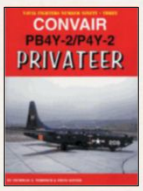


DOUGLAS AD/A-1 SKYRAIDER: Part Two *Ginter* Covers Skyraider Fleet and Utility squadrons with descriptions about each squadron along with vintage photos, squadron patches and unit insignia. 8-1/2 x 11, 272 pgs, 740 photos. SC Item # GB836... $55.95



HORTEN HO 229 FLYING WING: Spirit of Thuringia *Shepelev & Ottens* This book represents the most thorough technical study ever done on Nazis Germany's Horten Ho 229 flying wing and is certain to appeal to WWII and x-plane enthusiasts, as well as modelers. 9 x 12, 128 pgs, 200 photos.
Item # CP366 ..... $49.95

COLLECTING VINTAGE PLASTIC MODEL AIRPLANE KITS *Kodera* The author examines vintage model airplane kits and highlights what collectors should look for in building their collections. Covers model development in the heyday, and includes pricing for vintage kits. 8-1/2 x 11, 128 pgs, 440 photos. SC
Item # SP162 ..... $24.95



CONVAIR PB4Y-2/P4Y-2 PRIVATEER *Veronico* The land-based US Navy Privateer was a heavily armed, four-engine, long range patrol bomber and anti-shipping aircraft developed from the famous B-24/PB4Y-1 Liberator. 8-1/2 x 11, 240 pgs, 628 photos. SC
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MIKOYAN MiG-17: Famous Russian Aircraft *Gordon & Komissarov* The book fully describes the MiG-17's development history and combat operations in various major wars and local conflicts. A separate chapter also compares the MiG-17 and its foreign counterparts and concludes with details of MiG-17 fleets and operators worldwide. 8 x 11, 480 pgs, 1,200 photos. HC Item # MC372 ..... $64.95

HYPERSONIC: The Story of the North American X-15 *Jenkins & Landis* **This is the most extensively researched history of the X-15 program yet produced, written with the cooperation of surviving X-15 pilots as well as many other program principals. It covers the tasks of converting and testing the B-52 carrier airplanes and more. 9 x 9, 276 pgs, 550 photos, 100 drawings. SC Item # SP131 ..... ~~$28.95~~ $14.48**

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This series provides extensive detail; i.e., panel lines, wing folds, bomb loads, cockpit detail, and much more information via line drawings and photographs.

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BY **CLARENCE LEE**

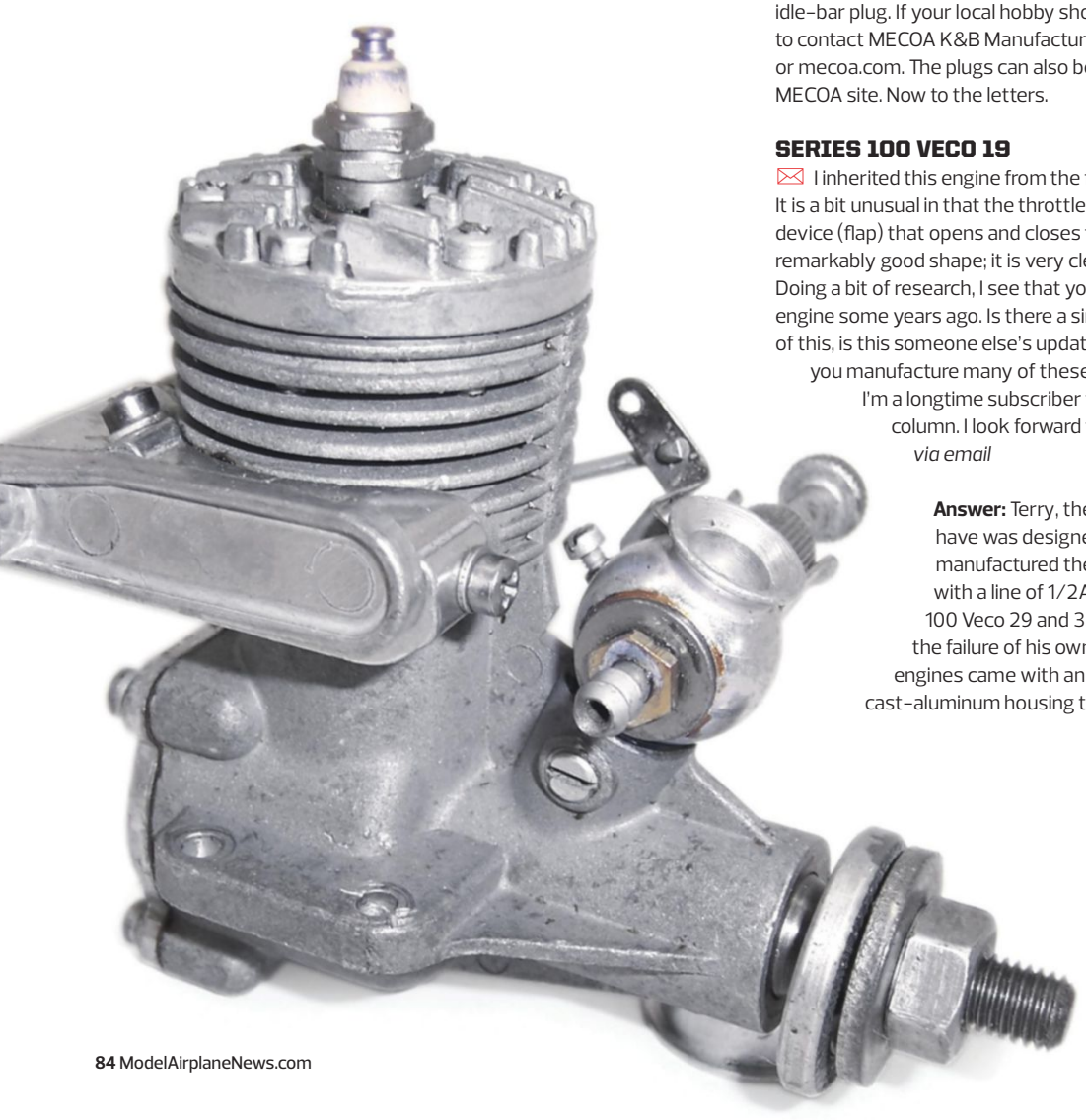
Idle-Bar Glow Plugs Are Back!

Q&A Email your questions to Clarence Lee at MAN@airage.com.

Many of our new modelers may not be aware of idle-bar glow plugs. This photo shows the bar in close detail.

Before we get to the letters this month, we have good news for readers who have earlier or modern-day cross-flow two-stroke engines that require an idle-bar glow plug for the best idle and acceleration characteristics. As many of you have found, idle-bar glow plugs are difficult if not impossible to find due to the fact that later Schnuerle ported engines usually don't require one, so plug manufacturers discontinued making them. In case you are in doubt as to whether your engine is of cross-flow or Schnuerle ported design, cross-flow engines have a baffle on the piston top that directs the incoming fuel mixture directly at the glow plug. Schnuerle ported engines have a piston with a flat top.

Now, after considerable arm-twisting on my part for the past few years, my friend Randy Linsalato (who, with his wife Anching, owns MECOA K&B) has put the K&B idle-bar plug back in production. Although cross-flow engines will show the most improvement with an idle-bar plug, if you have a Schnuerle ported engine that has a little to be desired when it comes to idle or acceleration, the answer could be to use an idle-bar plug. If your local hobby shop does not have the plugs, ask them to contact MECOA K&B Manufacturing at 626-359-6972, or kbmfg.com or mecoa.com. The plugs can also be ordered online directly from the MECOA site. Now to the letters.

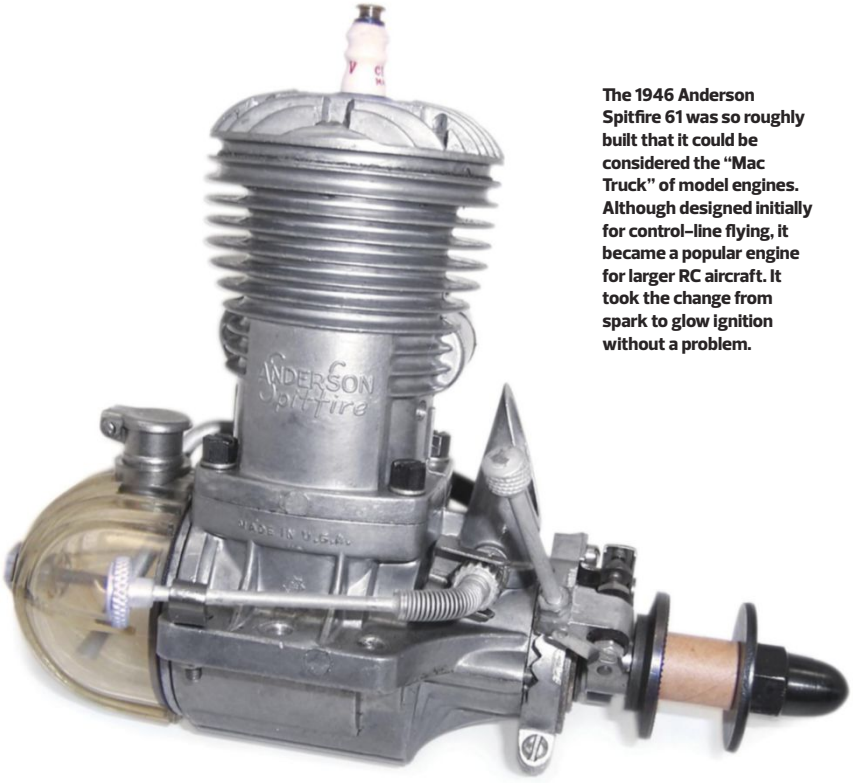


The RC version of the Series 100 Veco 19 was designed by Mel Anderson. This photo shows the exhaust wiper blade.

SERIES 100 VECO 19

✉ I inherited this engine from the family of a recently deceased friend. It is a bit unusual in that the throttle has a push rod connecting it to a device (flap) that opens and closes the exhaust port. The engine is in remarkably good shape; it is very clean and has excellent compression. Doing a bit of research, I see that you had a hand in developing this Veco engine some years ago. Is there a simple explanation of the mechanics of this, is this someone else's update, or are there parts missing? Did you manufacture many of these engines, or is it a collector's piece? I'm a longtime subscriber to *MAN* and a regular reader of your column. I look forward to hearing from you.—*Terry Faulkner, via email*

Answer: Terry, the original Series 100 Veco 19 that you have was designed by Mel Anderson, who formerly manufactured the Anderson Spitfire 61 and 65 along with a line of 1/2A engines. He also designed the Series 100 Veco 29 and 35 while working for Veco following the failure of his own company. The RC versions of these engines came with an exhaust assembly consisting of a cast-aluminum housing that fit over the engine exhaust stack



The 1946 Anderson Spitfire 61 was so roughly built that it could be considered the "Mac Truck" of model engines. Although designed initially for control-line flying, it became a popular engine for larger RC aircraft. It took the change from spark to glow ignition without a problem.

and had a blade-type wiper that closed off the exhaust as the carburetor was closed. This caused backpressure and heat that kept the glow plug hot at idle. Many thousands of these engines were made, and they are not particularly valuable as a collector's item. I designed the Series 200 Veco 19 that utilized a ball-bearing-supported crankshaft rather than a bronze sleeve bearing and a rotary exhaust baffle.

ALL SCREWED UP

✉ I have several problems that you may be able to help me out with. I have been taking apart and cleaning engines to sell on eBay. My first problem involves the difference I have found in various Phillips screwdrivers. There is a difference in the shape of the tip of the screwdrivers from different sources. In some cases, the tip appears to be too long and does not fit the slot in the screw head. Often the problem seems to pop up when using a Craftsman Number 1 screwdriver.

This leads to my next problem. When I have difficulty removing a screw and have rounded out the cross slot, I find it almost impossible to remove the screw. Do you know of a source that makes a screw extractor for small screws like 2-56 and 4-40? Recently I was taking an old McCoy 60 apart and noticed that the screw heads appeared to be white. I determined that the zinc plating on the screws had turned into a white powder. Will this cause the screws to be harder to remove? I also have found screws in other engines that are stuck, and if I get them out, the threads are filled in with congealed oil and dirt. Should I be doing some preliminary operation prior to taking the engine apart for soaking in the crock pot or ultrasonic cleaner?—*Art Johnson, Rockford, IL*

Answer: Art, your Phillips-head screwdrivers come in various sizes depending on the size of the screw, and as you have found out, one size is not going to fit all screw sizes. If too large, it will not fit the screw, and too small will round out the head. Generally, a small or medium size will fit most model-engine screws. An exception here would be the old McCoy 60. It is not very well known, but there are actually two different Phillips-type screw heads: the conventional head that most people are familiar with and the Reed & Prince generally used on aircraft. The latter have narrower slots and require a special screwdriver.

Duromatic, which made the McCoy 60, bought the screws as war surplus following World War II. Not generally known is that Duromatic also used ball bearings taken from Norden bombsights, which hospitalized war vets disassembled. The screws had a cadmium-plated finish, which develops a white powder as it ages. Nickel plate, which is more commonly used nowadays, has a bluish tint and does not develop the white powder. Easy Out has an extractor, available at most hardware stores, small enough for 6-32 size screws, but I do not know of one for 4-40 or 2-56 screws. I do not believe that either a crock pot or ultrasonic cleaner will help much with loosening frozen screws. I can usually get them out by putting the screwdriver in a drill-press chuck and, while applying pressure, turning the chuck by hand.

TIP OF THE MONTH

Carbon Buildup

Our tip of the month may sound familiar to some of our longtime readers as we originally ran it five years ago in the July 2012 issue. However, with many new readers not familiar with what has been done in the past, here it is again.

Do you have a gas burner that has seen considerable running time and has now started to kick back occasionally when starting, become more critical on the needle-valve setting, and doesn't quite turn up like it used to? Well, this could just be a case of carbon buildup in the combustion chamber. The fix is easy: Just go to your local auto-parts store and get a bottle of fuel-injector cleaner. Then, with the engine running at a fast idle, dribble a few ounces down the carburetor intake while occasionally running the engine up to full throttle. Then add a couple of ounces to a gallon of fuel to keep the engine nice and clean. Caution: Do not do this to a glow ignition engine unless you are sure it does not contain any silicone rubber parts, such as the regulator diaphragm on YS engines and the pump on O.S. pump-equipped engines. Petroleum-based products will turn silicone rubber into goo.

Fuel-injector cleaner is an easy way to clean out varnish and carbon from inside your gas-burner engines and eliminate having to disassemble your engine.

O.S. 120 SURPASS

✉ I have an older O.S. 120 Surpass pump (circa 1988) that runs powerfully and idles perfectly. I have a concern, however: When operating on the ground, it runs great—maybe a little lean, but one click on the needle valve and it slows way down to a super-rich run. Is this typical of pumper engines? Do you think there may be some other issue at work? The plane would never get airborne during the rich run but would jump in the one-click leaner mode.—*Ray Johanson, via email*

Answer: Ray, this is a problem with the older O.S. pumped 120s we have talked about quite a few times over the years. The fix is to install a T-fitting in the fuel line next to the carburetor and another in the fuel return line to the fuel tank. Then connect the two T-fittings together. This will lower the pump pressure and help the problem. If not, the diaphragm in the pump-regulator section has probably hardened. I do not believe that O.S. has made repair parts available as they caution about taking the pump apart in their operating instructions. Check with the service department at Tower Hobbies, who import the O.S. engines, to see if repair parts might be available. If you strike out here, get a muffler pressure fitting from Macs Products (macspro.com) and bypass the pump using muffler pressure.

FOUR-STROKE NEWBIE

✉ I am just starting in four-stroke engines and was told they would not run right with the cylinder straight up. Is this true?—*A. J., via email*

Answer: A. J., someone sure gave you some bad information. Upright is the way both the four-stroke and two-stroke engines are supposed to be run. You may have misunderstood what the person was saying, which was probably that the engine would not run properly unless the cylinder was straight up. Engines can become more temperamental when run inverted because they can more easily flood during starting, it's harder to get a reliable idle, etc. Many fellows are running both two- and four-strokes inverted without a problem. However, this should only be done if you have engine-running experience.

EVOLUTION 52

✉ I have been reading your column since 1989 and have always enjoyed it. I know I have read this question in your column before, but a check of my back issues of *MAN* was of no help, so I will ask it again. The problem is with an Evolution 52 that a friend brought to me. It was stored for five months, and all the limiters are removed. I can get it running, but as soon as the glow starter is removed, it dies (just as if I had shut off the ignition). The plug has been changed, I used a different fuel, I ran it without the muffler—all with no luck. I hope you can provide me with some guidance.—*Dan Hayes, Hoschton, GA*

Answer: Dan, you did not say if the engine has good compression and can be hand-started. I'm assuming not and the engine is just worn out and cannot develop sufficient combustion heat to keep the glow plug lit.

That does it for this month. We'll be back in the June issue.

Product Watch

MINI REVIEWS OF EDITORS' FAVORITES

Hitec X2 700

With the exception of the power input cord on side 1 (left side), both side panels are identical. Banana jack charge lead and balance outputs, and temperature sensor and USB ports make necessary connections easy and convenient.

Flying large electric models requires large batteries, both in cell count and capacity. That's just a fact of life, and charging those batteries requires more power than many of the chargers available today can provide. Hitec has recently introduced the X2 700 charger to address that requirement.

The X2 700 is a multi-chemistry, microprocessor-controlled DC-powered charger that's actually two independent chargers in one package. Each side of the charger is capable of up to 700W of output power with the appropriate power supply. Capable of charging Ni-Cd, NiMH, and lead-acid batteries, it can also charge and maintain a variety of lithium battery chemistries, including lithium polymer (LiPo), lithium ferrite (LiFe), lithium ion (Li-Ion), and the new high-voltage LiPo (LiHV) cells.

The X2 has six methods of charging for lithium batteries. Balance Charge mode is the one that will likely be used most often, using an independent internal balancer to keep individual cells in a battery balanced with each other. Regular Charge and Fast Charge modes don't use the internal balancer. Storage mode checks the battery's voltage and, depending on the state of charge, either charges or discharges the battery to a safe storage voltage. The Micro Charge and Micro Storage modes both use smaller charge current ranges, from 10 to 500mA, for safe maintenance of micro-size batteries.

Synchronous mode allows both sides of the charger to be set using the controls on side one, for charging two identical batteries. Up to 10 battery profiles can be stored to make setup for charging more convenient. Safety features include processing time and capacity limits that are user adjustable, and an optional temperature probe allows a battery temperature limit to be enabled. Input power monitoring keeps track of the input voltage and shuts off charger operation to prevent damage to the battery powering the charger. Hitec's free Charge Master PC software allows the user to control and monitor the charger by computer as well as update firmware and set up the charger.

With two informative displays and only four buttons for each side, the X2 700 is simple and intuitive to use. Total output power is dependent on the choice of power supply. On a 12V source, each side of the charger will put out up to 350W. The full 700W-per-side output power requires a 24V power supply, like Hitec's ePowerBox 50A power supply.

Hitec's X2 700 is a well-designed and capable solution for those who need a higher power charger. It's available for about $200 at many online vendors.

—John Kauk

hitecrcd.com

The X2 700 consists of two chargers in one case, which is very handy when you have a range of batteries to charge for a flying session. Here, a 3S 3200mAh battery is charging on side 1 and a 6S 5000mAh battery on side 2. With up to 700 watts of power available on each side, parallel charging is possible to charge multiple batteries quickly.

WarbirdPilots.com
Scale Pilot Figures

The pilot comes with a detailed helmet with a movable visor and removable oxygen mask. The figures are also offered with multiple color (red, orange, yellow, blue, and black) flight suits and helmets.

When it comes to flying scale model aircraft, there's one basic rule no self-respecting scale builder/pilot should ever break: "Never fly your plane with an empty cockpit!" A scale pilot figure (or, at the very least, a shoulders-up pilot bust) is not an optional accessory; it's a requirement if you're serious about presenting your aircraft in a scalelike, prototypical fashion. OK, I will hop off my scale soapbox now. But it is true that your scale model airplane—whether it is an open-cockpit World War I biplane, a bright yellow Piper Cub, or a modern-day jet fighter with a bubble canopy—will look more realistic if there's someone in the main office.

No gluing anything together or painting required, you can get a full-length pilot figure ready to strap into the cockpit from Adam Martin, the guy who runs WarbirdPilots.com. Having a scale modeling background, Adam got tired of seeing guys putting Barbie dolls into their Mustangs, so he went into business with the idea of producing realistic-looking pilots that can be posed to fit any cockpit. Add accurate flight gear and clothing and WarbirdPilots.com pilot figures are some of the most popular choices for demanding scale modelers and for sport fliers alike.

Adam's new line of highly detailed 10-inch-tall modern jet pilot figures are sized to fit perfectly in any 1/7- and 1/8-scale jet or modern prop-driven warbird. Each figure has a cotton-filled body with a wire frame, allowing them to be posed in any position. And important to any scale modeler, these pilot figures weigh only 4 ounces. Each jet pilot figure includes the 10-inch-tall figure with an all-new professionally painted head, a detailed HGU-55 jet helmet with visor and removable oxygen mask, green flight suit, flight harness straps, and black boots and gloves. An excellent value, the 1/7 to 1/8 Modern 10-inch Jet Pilot Figures start at $79.99. WarbirdPilots.com pilot figures are also available in several other sizes and styles, to cover all WW I, WW II, modern jet, and civilian aircraft.—*Gerry Yarrish*

warbirdpilots.com

RAM Products
Strip LED Nav Lights

Have you been thinking of adding lights to your favorite sport flier for nighttime fun? Ralph Warner over at RAM Products is constantly adding to his line of RC model airplane–specific lighting systems, and his latest includes two sets of LED strip lighting. Set RAM 198 comes with 36 inches of stick-on lighting with more than 60 high-intensity LEDs (weighing only 20g) that are wired for a 2-cell LiPo pack, so there's no soldering required. Priced at $24.95, these LED strips are about 1/4 inch wide and easily stick to any model surface. Voltage consumption is about 15mA per 10 minutes of flight time. Set RAM 199, priced at $29.95, includes 72 inches of LED stick-on strip (weighing only 33g) and includes more than 100 LEDs. Wired for a 3-cell LiPo pack, consumption is about 100mA per 10-minute flight.

Each set comes with red, green, and white LEDs and is wired with a connector that mates to the LiPo packs' balance plug, so there's no switch required. (Battery packs not included.) Just install the battery in your model, cut a small opening for the lead to pass through, and arrange your LED strips so that you can make the connection before you fly. They're all super easy to install and use. You can also see Ralph's entire lighting catalog online.—*Gerry Yarrish*

ramrcandramtrack.com

Final Approach

TEXT & PHOTOS BY **CLARK SALISBURY**

Teamwork

Drones and planes flying together

Since the beginning of the year, I have been enjoying flying my new drone, the DJI Phantom 3 Pro. I am also extremely impressed with the 4K video that it can produce. While watching an online video, I saw a demonstration of a drone lifting 2 pounds straight up. About this time, I was also thinking about designing my own RC glider. So these two ideas came together, and I decided to try and lift my glider with my Phantom so that it could be launched/released at the maximum AMA (Academy of Model Aeronautics) altitude of 400 feet. I could then pilot the glider back to the ground, using a separate radio. A 40-inch wingspan would be about right for the glider, and I wanted to keep the weight at 12 to 13 ounces. I, of course, would need a drone pilot to help me with this launch.

I discovered that others had similar ideas, but the launches were plagued with the same problem: While using a string or cord to lift the glider, the string would invariably get tangled up with one of the drone's props after the glider release—not a good situation. My idea was to lift the glider by its tail, attached directly to the drone. No strings would be involved, and the release mechanism would be controlled by a servo in the glider. To test my device, I built a stand about 27 inches high for the drone to sit on so that I could work out the attachment/release mechanism.

My final design turned out to be the SkyGlider, and as you can see, it works pretty well. A note here is that I have only tested this lifting method with the DJI Phantom 3 drone. It has built-in three-axis stabilization and easily compensates for lifting the uneven load. If you try this with a different drone, be sure to test it safely before flying to altitude.

It's true: Drones and RC airplanes can play nice together. By teaming up to launch lightweight gliders, a whole new sport might begin to grow.

Above left: The author's SkyGlider is lifted to 400 feet using his DJI Phantom 3 drone (flown by another pilot). Above right: The T-tail SkyGlider has a 40-inch span and weighs about 13 ounces. The release mechanism is incorporated into the glider's tail just below the rudder.

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